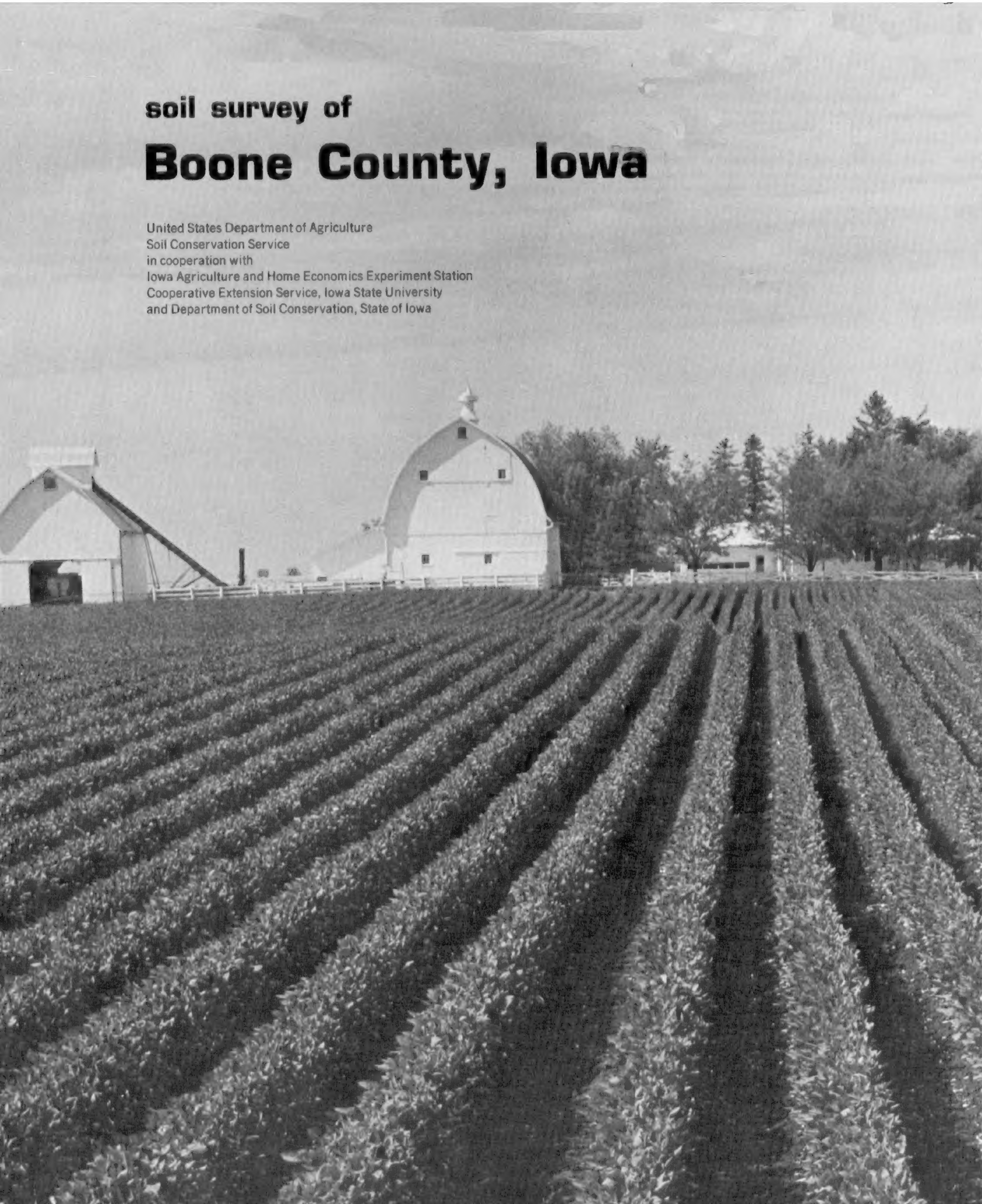
soil survey of

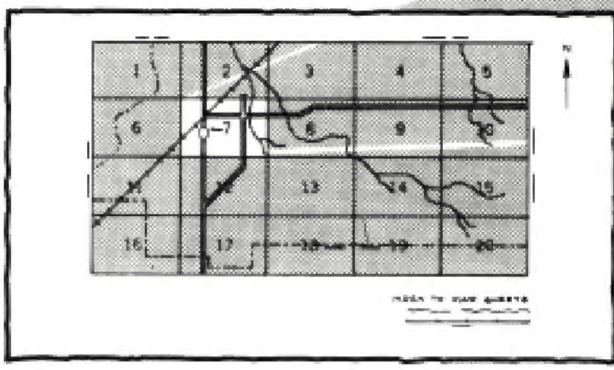
Boone County, Iowa

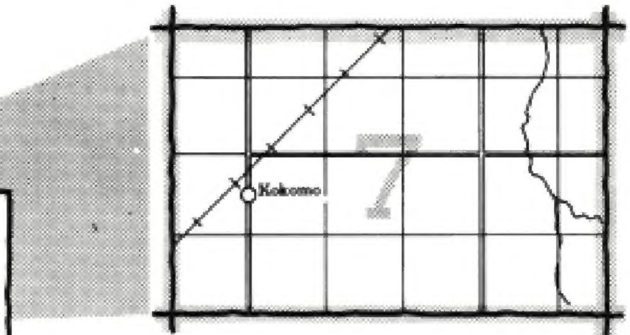
United States Department of Agriculture
Soil Conservation Service
in cooperation with
Iowa Agriculture and Home Economics Experiment Station
Cooperative Extension Service, Iowa State University
and Department of Soil Conservation, State of Iowa



HOW TO USE

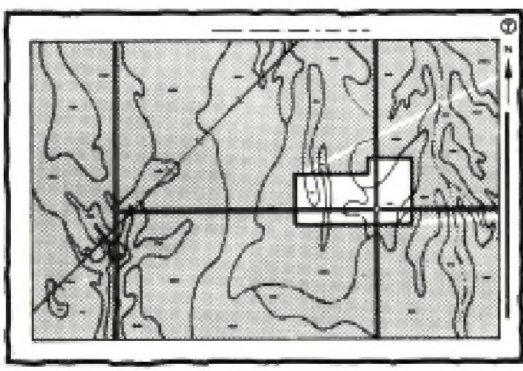
1. Locate your area of interest on the "Index to Map Sheets"

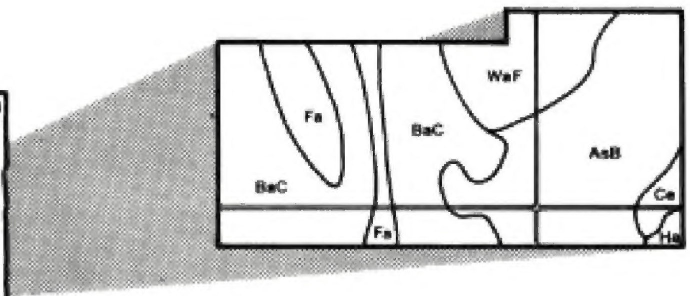




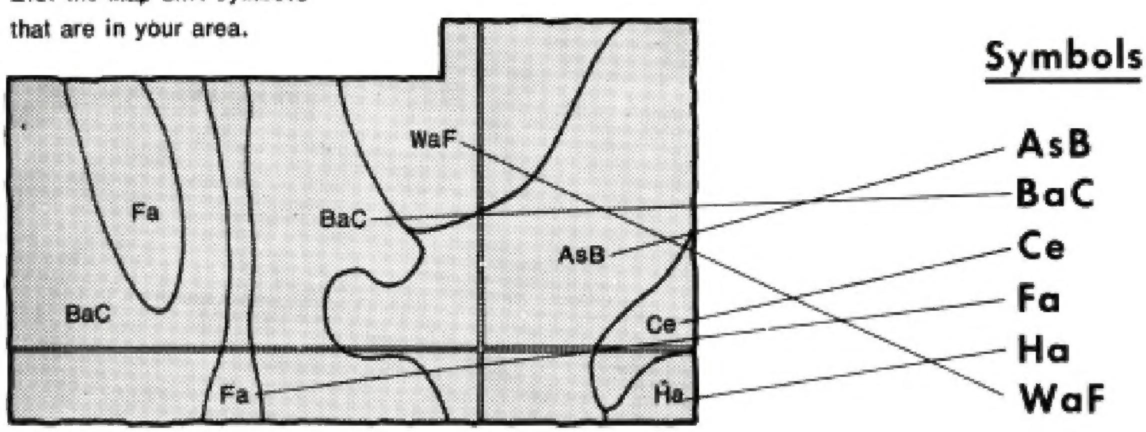
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



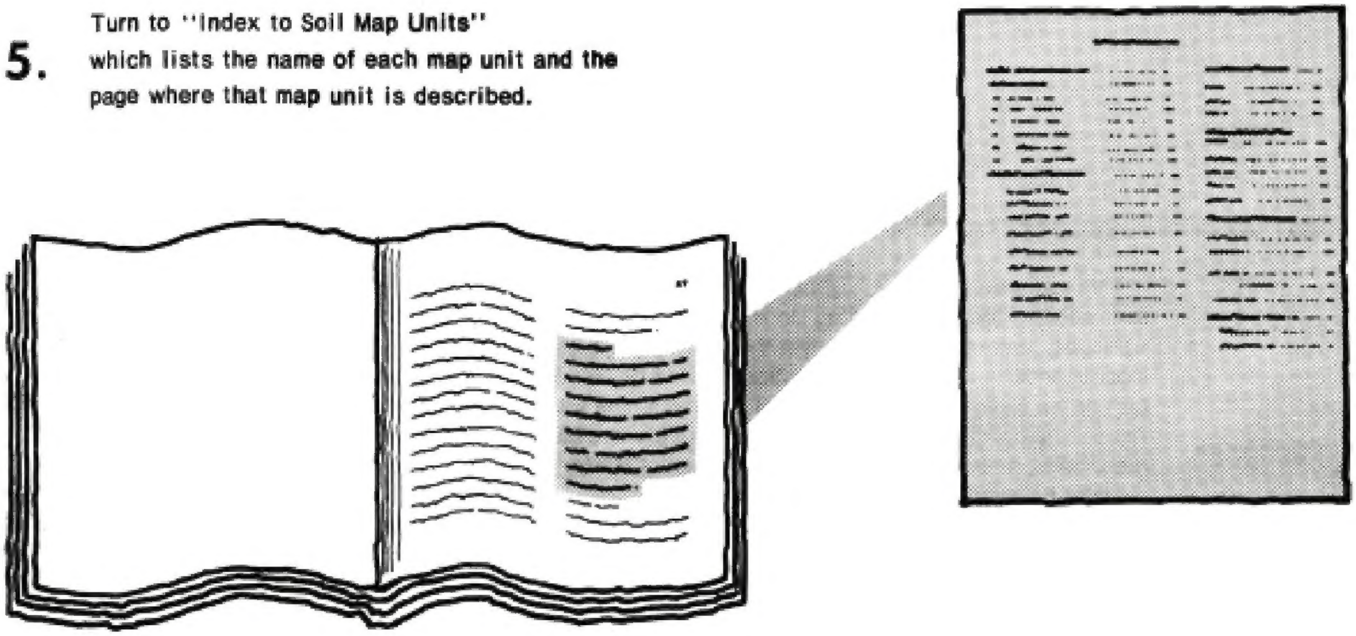


4. List the map unit symbols that are in your area.

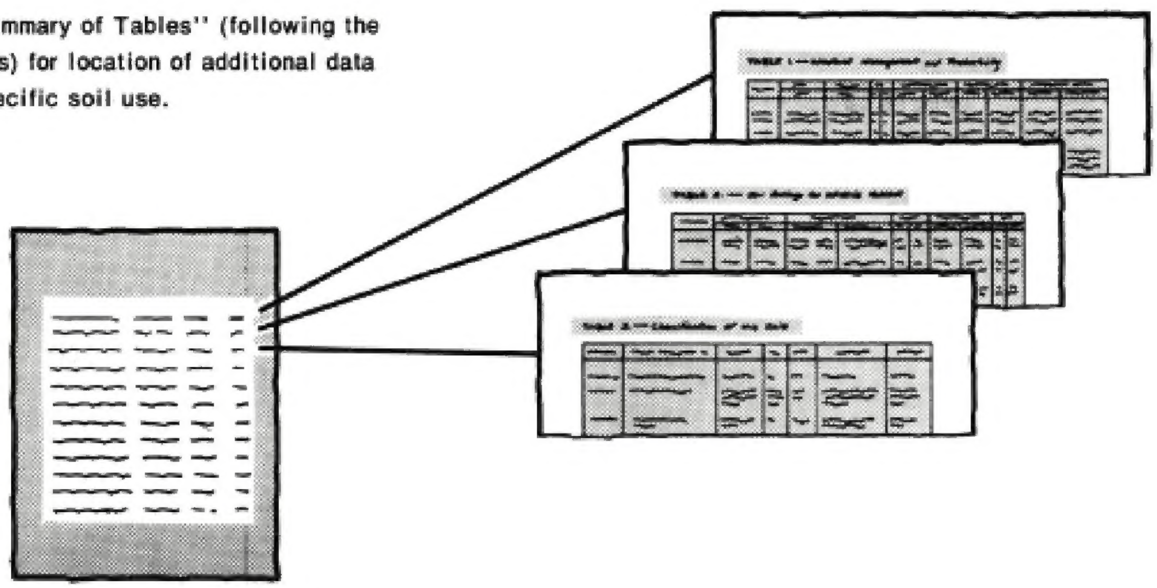


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1972-1975. Soil names and descriptions were approved in 1977. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1975. This survey was made cooperatively by the Soil Conservation Service; the Iowa Agriculture and Home Economics Experiment Station; the Cooperative Extension Service, Iowa State University; and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Boone County Soil Conservation District. Funds appropriated by the State of Iowa and Boone County were used to defray part of the cost of this survey.

This soil survey supersedes a soil survey of Boone County published in 1923.

Cover: Soybeans on Nicollet loam, 1 to 3 percent slopes. In most areas this soil is intensively row cropped.

contents

soil series

Issued February 1981

index to map units

summary of tables

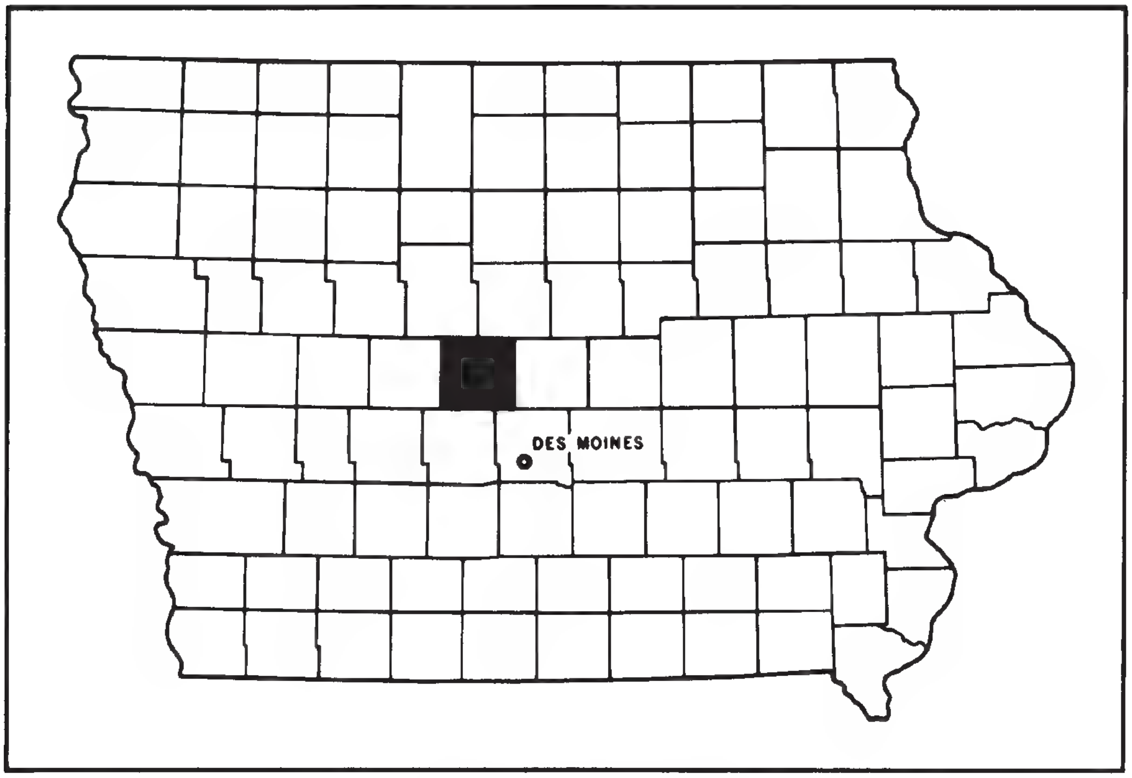
preface

This soil survey contains information that can be used in land-planning programs in Boone County, Iowa. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.



Location of Boone County in Iowa.

Soil survey of Boone County, Iowa

By Wells F. Andrews and Robert O. Dideriksen, Soil Conservation Service

Fieldwork by Wells F. Andrews, Robert O. Dideriksen, Earl D. Lockridge, and Roger A. Greenough, Soil Conservation Service, and Gregory I. Igl, Iowa Agriculture and Home Economics Experiment Station

United States Department of Agriculture,
Soil Conservation Service, in cooperation with
Iowa Agriculture and Home Economics Experiment Station;
Cooperative Extension Service, Iowa State University; and
Department of Soil Conservation, State of Iowa

BOONE COUNTY is in the central part of Iowa. It has a total area of 366,560 acres, or 573 square miles. Boone, the county seat, has a population of 12,648.

Most of the soils in Boone County are nearly level to undulating. The soils formed under prairie vegetation and are dark and fertile. The Des Moines River flows to the south through the middle of the county. The slopes adjacent to the river are very steep and are forested. The elevation ranges from 1,250 feet in the northeastern part of the county to 840 feet in the Des Moines River Valley along the southern border of the county.

Most of the acreage is in farms. Corn and soybeans are the main crops. The raising of hogs and the feeding of beef cattle are the principal livestock enterprises.

Winters in Boone County are cold, summers are warm, and the growing season is long enough for crops grown in the county to mature.

general nature of the county

This section gives general information concerning the county. It discusses settlement, natural resources, climate, farming, transportation, and industry.

settlement

The area that is now Boone County was settled in 1846, about the time that Iowa was admitted to the union as a state. Charles W. Gaston was the first settler. Boone County, with its present boundaries, was established in February, 1847. The county was named after Nathan Boone, son of Daniel Boone (*4, 17*).

In 1850, the population of the county was 735. By 1910, the population had grown to 27,626. By 1970, however, according to the census of that year, the population of Boone County had declined to 26,470.

Towns and villages in Boone County include Boone, Madrid, Ogden, Boxholm, Luther, Fraser, Beaver, Berkley, Pilot Mound, and Ridgeport.

There are elementary and high schools in the county and a junior college in Boone. Iowa State University maintains several experimental farms in the county.

natural resources

Soil is the most important natural resource in the county.

In most of the county, the water supply is adequate for domestic use and for livestock. Deep wells near the Des

Moines River furnish most of the water for domestic use in Boone, Ogden, and Madrid.

Coal was once an important natural resource in the county. However, at the present time no coal mines are in operation.

Some areas along the Des Moines River and Beaver Creek are good sources of sand and gravel. These areas are mainly on benches that run parallel to the drainageways.

climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Boone County is cold in winter and hot in summer. There are occasional cool spells in summer. Precipitation in winter frequently occurs as snowstorms. During the summer warm moist air moves in from the south, and precipitation is chiefly showers, which are often heavy. Total annual rainfall is normally adequate for corn, soybeans, and small grains.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Boone, Iowa in the period 1951 to 1974. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 22 degrees F, and the average daily minimum temperature is 13 degrees. The lowest temperature on record, which occurred at Boone on January 13, 1974, is -27 degrees. In summer the average temperature is 72 degrees, and the average daily maximum temperature is 84 degrees. The highest temperature, recorded on July 30, 1974, is 104 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 33.4 inches. Of this, 24 inches, or 73 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 20 inches. The heaviest 1-day rainfall during the period of record was 4.09 inches at Boone on June 25, 1968. Thunderstorms occur on about 50 days each year, and most occur in summer.

Average seasonal snowfall is 32 inches. The greatest snow depth at any one time during the period of record was 35 inches. On an average of 25 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 81 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 13 miles per hour, in April.

Tornadoes and severe thunderstorms occur occasionally. These storms are local and are brief. They cause scattered damage in narrow belts. Hailstorms occur during the warmer part of the year in an irregular pattern and in relatively small areas.

farming

Farming is the main enterprise in Boone County. The soils have good potential for high crop yields if properly managed.

At one time, a large part of Boone County was wet and poorly drained, and only the better drained sections were settled at first. The early settlers favored the wooded areas along the Des Moines River, where the forest provided fuel and gave protection from the severe storms in winter. Game was plentiful. Farming was restricted to a few small fields in which grain was grown for home use. Corn, wheat, and oats were the principal crops. A few head of cattle were kept on most farms.

The increase in population and in the number of farms was gradual until the early 1850's. After the building of railroads, which provided improved marketing facilities, growth was much more rapid. Later, because of the increased demand for agricultural land and its consequent increased value, a complete system of drainage was devised (*18*).

More and more farmers began to recognize the need for good management. On March 9, 1946, the Boone County Soil Conservation District was organized. In the years following, conservation practices have been increasingly applied (*3*).

About 343,000 acres of the county is farmland. The average farm is about 260 acres in size. More than 80 percent of the farmland is used for crops, mainly corn and soybeans.

Because of increased emphasis on corn and soybean production, livestock production has decreased. In 1974, corn was raised on 1,064 farms and soybeans on 970. Cattle were raised on only 537 farms and hogs on 466 (*7*).

transportation and industry

U.S. Highway 30 serves east-west traffic, and U.S. Highway 169 serves north-south traffic across the county. These highways intersect at Ogden and connect with all parts of the county by State Routes 329, 17, 89, and 144 and by county roads. Most farms have access to hard-surfaced or graveled roads. Railroad lines serve most towns in the county. There is one small airport, located in the city of Boone.

Farming is the main enterprise, but there is some industry in the county, mainly in the city of Boone. Among the products manufactured are concrete tile,

grain aeration equipment, fertilizer blenders, prefabricated houses, refrigeration units, and paper products. There are two seed corn companies and many grain elevators. Boone has a large baking company. Metal fabrication is also an important industry.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, woodland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit, or soil association, on the general soil map is a unique natural landscape. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

soil descriptions

1. Canisteo-Clarion-Nicollet association

Nearly level to moderately sloping, poorly drained, well drained, and somewhat poorly drained, loamy soils on uplands

This association consists of nearly level to gently rolling soils in swells and swales (fig. 1). Many potholes are scattered throughout the broad level areas. Natural drainage is very poor. The soils in most of the areas are drained by tile and surface inlets. Large drainage ditches have been dug to provide outlets for tile drains.

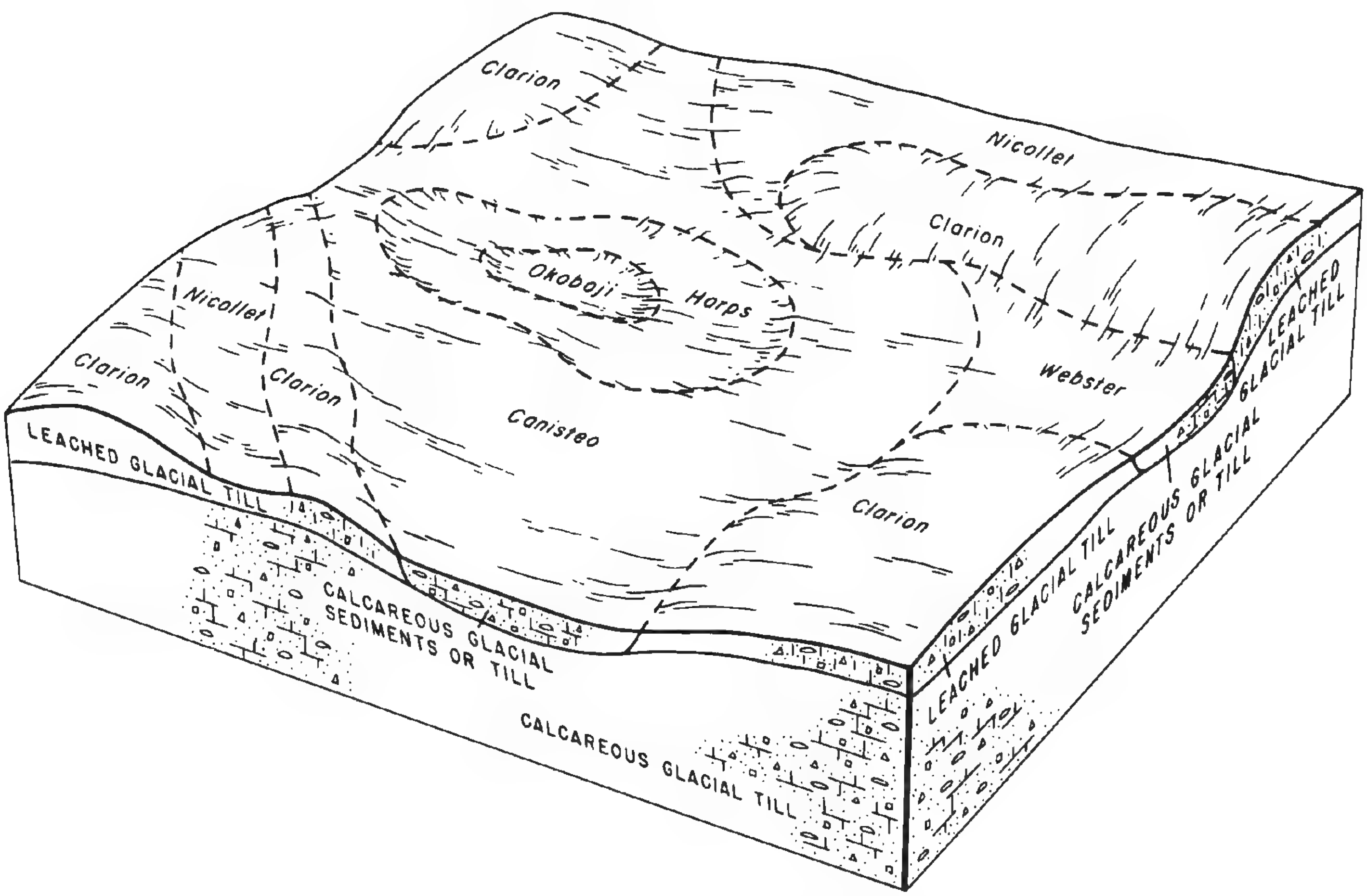


Figure 1.—Relationship of slopes and parent material to the soils in the Canisteo-Clarion-Nicollet association.

This association makes up about 78 percent of the county. It is about 29 percent Canisteo soils, 27 percent Clarion soils, 14 percent Nicollet soils, and 30 percent minor soils.

Canisteo soils are nearly level and are on broad upland flats. They are poorly drained. Typically, their surface layer is black calcareous silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray calcareous clay loam about 10 inches thick. The subsoil is about 18 inches thick. In the upper part it is dark gray and olive gray, mottled calcareous clay loam, and in the lower part it is pale olive, mottled calcareous loam. The substratum to a depth of about 60 inches is light olive gray, mottled calcareous loam.

Clarion soils are gently and moderately sloping. They are well drained. Typically, their surface layer is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is dark brown, brown, and yellowish brown loam about 28 inches thick. The substratum to a depth of about 60 inches is light yellowish brown, mottled calcareous loam.

Nicollet soils are very gently sloping. They are somewhat poorly drained. Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is brown loam about 9 inches thick. The subsoil is about 20 inches thick. It is dark grayish brown, mottled loam. The substratum to a depth of about 60 inches is grayish brown and olive gray, mottled loam.

The minor soils in this association are Webster, Okoboji, Harps, and Storden soils. Webster soils are nearly level and are poorly drained. They are mainly in swales and drainageways that are generally slightly concave. In some areas they are on nearly level flats. Okoboji soils are in closed depressions and are very poorly drained. Harps soils are highly calcareous and are mainly on narrow rims around depressions. Storden soils are on moderately and strongly sloping convex knolls and are well drained.

Corn and soybeans are the principal crops on these intensively cultivated soils. Cash grain farming is the dominant type of farming. The content of organic matter is high to moderate, and the available water capacity of the major soils is high. The main concern of management is improvement of drainage and control of erosion on the sloping soils.

The major soils in this association are suitable for all crops grown in the county. These soils are poorly suited to urban development. Low soil strength, high shrink-swell potential, and a seasonal high water table are major hazards.

2. Hayden-Storden association

Very steep, well drained, loamy soils on uplands

These soils are on uplands along the Des Moines River. The uplands are generally very steep; numerous ravines and gullies cut back into the upland. The contrast in relief between the valley slopes and the narrow drainageways is a distinctive feature of this association.

This association makes up about 7 percent of the county. About 75 percent of the association is Hayden-Storden loams soil complex, and 25 percent is minor soils.

The Hayden-Storden loams are on the very steep valley slopes. Areas of the Hayden and Storden soils are so intermingled that they were not mapped separately.

Typically, the surface layer of the Hayden soils is very dark grayish brown loam about 2 inches thick. The subsurface layer is dark grayish brown loam about 8 inches thick. The subsoil is brown and yellowish brown clay loam about 12 inches thick. The substratum is yellowish brown, mottled calcareous loam to a depth of 60 inches.

Typically, the surface layer of the Storden soils is brown loam about 6 inches thick. The substratum is yellowish brown loam. Storden soils are calcareous throughout.

The minor soils in this association are Spillville and Buckney soils. These soils are gently sloping and are on narrow bottom lands. They are subject to flooding by the adjacent streams.

In most areas the soils in this association are wooded. Generally they are used for pasture rather than as woodland, but a few small tracts are managed as woodland. The soils have good potential for use as wildlife habitat. The main concern of management is control of water erosion.

The major soils in this association are poorly suited to cultivated crops and to urban development. Slope is the major limitation.

3. Hayden-Lester-Luther association

Nearly level to moderately sloping, well drained and somewhat poorly drained, loamy soils on uplands

This association consists of soils on rises and in swales. The topography is nearly level to gently rolling. The swales connect with deep gullies extending from the side slopes of the Des Moines River Valley. Some strongly sloping soils are along the drainageways and gullies that extend into areas of this association.

This association makes up about 7 percent of the county. About 35 percent of the association is Hayden soils, 20 percent is Lester soils, and 10 percent is Luther soils. The rest is minor soils.

Hayden soils are on convex rises and narrow ridgetops and are gently and moderately sloping. They are well drained. Typically, their surface layer is very dark grayish brown loam about 2 inches thick. The subsurface layer is dark grayish brown loam about 8 inches thick. The subsoil is yellowish brown clay loam about 32 inches thick. The substratum to a depth of 60 inches is light olive brown calcareous loam.

Lester soils are on convex rises and narrow ridgetops and are gently and moderately sloping. They are well drained. Typically, their surface layer is very dark grayish

brown loam about 7 inches thick. The subsoil is dark yellowish brown clay loam about 25 inches thick. The substratum to a depth of 60 inches is mottled brown loam.

Luther soils are in flat to slightly convex areas and are nearly level. They are somewhat poorly drained. Typically, their surface layer is very dark grayish brown loam about 4 inches thick. The subsurface layer is dark grayish brown loam about 10 inches thick. The subsoil is brown clay loam about 20 inches thick. The substratum to a depth of 60 inches is mottled, grayish brown and yellowish brown calcareous loam.

The minor soils in this association are the Le Sueur, Webster, and Dundas soils. Webster and Dundas soils are in swales and low concave areas and are poorly drained. Le Sueur soils are on slightly convex rises and are somewhat poorly drained.

Corn, soybeans, and hay are the principal crops. In a few areas the soils are in permanent pasture or wooded pasture. Some farms are strictly cash-grain, but most also have income from livestock. The content of organic matter is moderate to low, and the available water capacity of the major soils is high. The main concerns of management are control of water erosion on the sloping soils and improvement of drainage on the poorly drained soils in the swales.

The major soils in this association are suitable for all crops grown in the county. These soils are suitable for urban development. Medium soil strength, moderate shrink-swell potential, and, in a few places, slope are hazards.

4. Clarion-Zenor association

Gently sloping to strongly sloping, well drained and somewhat excessively drained, loamy soils on uplands

These soils are on undulating to rolling convex knolls and in knobby outwash areas. They are predominantly gently and moderately sloping. They are steeper along major drainageways.

This association makes up about 3 percent of the county. About 25 percent of the association is Clarion soils, 25 percent is Zenor soils, and 50 percent is minor soils.

Clarion soils are gently and moderately sloping and are well drained. Typically, their surface layer is black and very dark grayish brown loam about 12 inches thick. The subsoil is brown and yellowish brown loam about 28 inches thick. The substratum to a depth of about 60 inches is light yellowish brown, mottled, calcareous loam.

Zenor soils are gently sloping to strongly sloping and are somewhat excessively drained. They are in knobby outwash areas on uplands. Typically, the surface layer is very dark brown and dark brown sandy loam about 12 inches thick. The subsoil is dark yellowish brown loam and sandy loam. It is underlain by yellowish brown loamy sand at a depth of about 28 inches.

The minor soils in this association are Storden, Salida, and Coland soils. Storden soils are moderately sloping to steep and are well drained. They are calcareous throughout. These soils are on convex slopes and are adjacent to Zenor and Salida soils. Salida soils are moderately sloping to steep and are excessively drained. They are gravelly throughout. Coland soils are nearly level and are poorly drained. They are on bottom lands along drainageways.

Corn and soybeans are raised on the less sloping soils. The steeper soils are used for hay and pasture. Raising cash crops and livestock are the main enterprises. The content of organic matter is moderate, and the available water capacity of the major soils is moderate to high. The main concern of management is control of water erosion on the sloping soils.

These soils are suitable for all crops grown in the county. The strongly sloping soils in most areas are eroded, and natural fertility is lower. The soils in this association are suitable for urban development. In some areas slope is a hazard.

5. Coland-Talcot-Wadena association

Nearly level and gently sloping, poorly drained and well drained, loamy soils on bottom lands and stream benches

This association consists of nearly level to undulating convex rises, swales, and flats. It is on bottom lands, alluvial fans, and stream benches along Beaver Creek (fig. 2).

This association makes up about 3 percent of the county. About 20 percent of the association is Coland soils, 12 percent is Talcot soils, and 10 percent is Wadena soils. The rest is minor soils.

Coland soils, on first bottom lands, are nearly level and are poorly drained. Typically, their surface layer is black clay loam about 9 inches thick. The subsurface layer is black clay loam about 32 inches thick. The substratum to a depth of 60 inches is black clay loam that has mottles.

Talcot soils, on stream benches and terraces, are nearly level and are poorly drained. Typically, their surface layer is black clay loam about 7 inches thick. The subsurface layer is black clay loam about 16 inches thick. The subsoil is dark gray and olive gray, mottled, firm clay loam. It is underlain by olive gray sand and gravel at a depth of 38 inches. This soil is calcareous throughout.

Wadena soils, on stream benches and terraces, are nearly level and gently sloping and are well drained. Typically, their surface layer is very dark brown loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 13 inches thick. The subsoil is brown loam and sandy loam about 18 inches thick. It is underlain by variegated, calcareous coarse sand at a depth of about 38 inches.

The minor soils in this association are Cylinder, Biscay, Canisteo, and Clarion soils. Cylinder soils, on slightly convex rises on stream benches, are nearly level and

Figure 2.—Typical landscape in the Coland-Talcot-Wadena association. Coland soils are next to Beaver Creek, Wadena soils are on the light-colored rise in the center, and Talcot soils are in the level areas in the background.

are somewhat poorly drained. Biscay soils are in the nearly level areas on stream benches and are poorly drained. Canisteo soils, on broad upland flats adjacent to the stream benches, are nearly level and are poorly drained. Clarion soils are in the gently sloping upland areas adjacent to the stream benches and are well drained.

Corn, soybeans, and hay are the principal crops. The soils adjacent to Beaver Creek are used for pasture. Most farms are strictly cash-grain, but there are beef cow herds on some farms. The content of organic matter is moderate to high, and the available water capacity of the major soils is moderate to high. These soils tend to be somewhat droughty if rainfall is below normal. The main concern of management is improvement of drainage on the poorly drained soils.

The major soils have good potential for all crops grown in the county. These soils have poor potential for urban development. Low soil strength, high shrink-swell potential, a seasonal high water table, and the hazard of flooding are limitations. The soils have poor potential for sewage lagoons. Ground water contamination is a hazard because of the sand and gravel underlying the soils in most areas.

6. Buckney-Moingona-Sattre association

Nearly level to moderately sloping, excessively drained, moderately well drained, and well drained, loamy soils on bottom lands, alluvial fans, foot slopes, and stream benches

These soils are along the Des Moines River and are predominantly gently and moderately sloping. They are steeper in a few places on the lower side slopes of the Des Moines River Valley (fig. 3).

This association makes up about 2 percent of the county. About 41 percent of the association is Buckney soils, 30 percent is Moingona soils, and 20 percent is Sattre soils. The rest is minor soils.

Buckney soils are on bottom lands and are very gently sloping. They are excessively drained. In areas adjacent to the Des Moines River they are frequently flooded and receive deposition. Typically, the surface layer is very dark brown and very dark grayish brown fine sandy loam about 12 inches thick. The subsurface layer is very dark

grayish brown and dark brown fine sandy loam about 5 inches thick. The substratum is brown and very dark grayish brown loamy sand and sandy loam.

Moingona soils are on foot slopes and are gently and moderately sloping. They are moderately well drained. Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is very dark grayish brown loam about 5 inches thick. The subsoil is about 28 inches thick. It is brown loam in the upper part and dark yellowish brown clay loam in the lower part. The substratum is dark grayish brown sandy loam to a depth of about 60 inches.

Sattre soils are on stream benches and are nearly level to moderately sloping. They are well drained. Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsurface layer is brown loam about 6 inches thick. The subsoil is brown loam and dark yellowish brown loamy sand about 28 inches thick. The substratum is yellowish brown sand.

The minor soils in this association are Coland and Hanlon soils. Coland soils are poorly drained and are subject to flooding. Hanlon soils are on natural levees and are moderately well drained.

In many areas along the river the soils in this association are wooded. The nearly level soils are used for cultivated crops; however, those soils may be flooded occasionally. Corn, soybeans, and hay are the principal crops. The content of organic matter is moderate, and the available water capacity of the major soils is moderate to high. The main concern of management is control of water erosion on the sloping soils.

The major soils have fair potential for all crops grown in the county, provided the soils are protected from flooding. The sloping soils have good potential for dwellings. The nearly level soils have poor potential for dwellings and urban development because of the hazard of flooding.

Approximately 60 percent of this soil association is within the flood pool of Saylorville Lake. The soils in this area may be subject to flooding of long duration.

Figure 3.—Typical area of the Buckney-Moingona-Sattre association. Moingona soils are in the foreground.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Hayden loam, 5 to 9 percent slopes, is one of several phases in the Hayden series.

Some map units are made up of two or more major soils. These map units are called soil complexes.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Coland-Spillville complex, 2 to 5 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Dumps, mine is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

This soil survey supersedes the soil survey of Boone County published in 1923 (*18*). This survey provides additional information and contains larger maps that show the soils in greater detail.

soil descriptions

6—Okoboji silty clay loam, 0 to 1 percent slopes. This is a level, very poorly drained soil in concave depressions on uplands. It is subject to ponding after heavy rains. The areas are rounded and range from 2 to 10 acres in size.

Typically, the surface layer is black silty clay loam about 14 inches thick. The subsurface layer is black silty clay loam about 20 inches thick. The subsoil is black, mottled silty clay loam about 20 inches thick. The substratum to a depth of 60 inches is very dark gray, mottled clay loam.

Included with this soil in mapping are a few small areas of Harps soils, which are poorly drained and calcareous throughout. The soils are on the edge of small depressions and make up 2 to 5 percent of the map unit.

Permeability is moderately slow, and surface runoff is slow to ponded. The available water capacity is very high. The surface layer is 6 to 8 percent organic matter and has fair tilth. The subsoil is very low in available phosphorus and potassium. This soil has high shrink-swell potential and a seasonal high water table.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated. Crops drown out in many places, and winterkilling of legumes is a hazard. This soil is slow to warm in spring, and because it is in low areas, crops are subject to damage by early frost.

This soil is in capability subclass IIIw.

27C—Terril loam, 5 to 9 percent slopes. This is a moderately sloping, moderately well drained soil on

slightly concave foot slopes. The areas are long and narrow and range from 5 to 10 acres in size.

Typically, the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 20 inches thick. The subsoil is 32 inches thick. It is brown, dark brown, and dark yellowish brown friable loam. In some places, the subsoil is dark grayish brown.

Included with this soil in mapping are small areas of Spillville soils that have a seasonal high water table. The Spillville soils are in less sloping areas and in small drainageways. They make up 2 to 10 percent of the unit.

Permeability is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is 4 to 5 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is cultivated, erosion is a hazard. In places, diversion terraces can be used to protect the soil from runoff and prevent rills and gullies from forming. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices.

If this soil is used as pasture or hayland, overgrazing causes surface compaction and increases runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

28B—Dickman fine sandy loam, 1 to 5 percent slopes. This is a gently sloping, well drained soil on convex upland side slopes along major streams. The areas are elongated and range from 2 to 30 acres in size.

Typically, the surface layer is very dark brown fine sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown sandy loam about 8 inches thick. The subsoil is about 34 inches thick. In the upper part it is dark brown sandy loam, and in the lower part it is multicolored loamy sand. The substratum to a depth of 60 inches is multicolored sandy loam, loamy sand, and silt loam. In some areas, loamy glacial till is at a depth of 40 inches. In some areas there is less sand throughout.

Permeability is rapid, and surface runoff is slow. The available water capacity is low. The surface layer is generally acid unless lime has been added. It is 2 to 4 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, water erosion and soil blowing are hazards. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices. Soil blowing can be reduced by conservation tillage or by leaving crop residue on the surface. Returning crop residue to the soil helps maintain good tilth, conserve moisture, and increase water infiltration. This soil is droughty in periods of below normal rainfall.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

28C—Dickman fine sandy loam, 5 to 9 percent slopes. This is a moderately sloping, well drained soil on uplands. It is on convex side slopes along major streams. The areas are long and narrow and range from 4 to 20 acres in size.

Typically, the surface layer is very dark brown fine sandy loam about 7 inches thick. The subsurface layer is very dark grayish brown sandy loam about 5 inches thick. The subsoil is about 33 inches thick. In the upper part it is brown sandy loam, and in the lower part it is yellowish brown loamy sand. The substratum to a depth of 60 inches is multicolored sand. In some areas glacial till is at a depth of 40 inches. In some areas there is less sand throughout.

Permeability is rapid, and surface runoff is medium. The available water capacity is low. The surface layer is generally acid unless lime has been added. It is 2 to 3 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, water erosion and soil blowing are hazards. Soil blowing can be reduced by conservation tillage or by leaving the surface rough. Returning crop residue to the soil helps maintain good tilth, conserve moisture, and increase water infiltration. This soil is droughty in periods of below normal rainfall.

If the soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

55—Nicollet loam, 1 to 3 percent slopes. This is a very gently sloping, somewhat poorly drained soil on uplands. It is on slightly convex rises that have low relief. In some places, this soil is on toe slopes. The areas are irregular in shape and range from 5 to 25 acres in size.

Typically, the surface layer is black and very dark gray loam about 11 inches thick. The subsurface layer is very dark grayish brown loam about 6 inches thick. The subsoil is dark grayish brown, mottled loam about 20 inches thick. The substratum to a depth of about 60 inches is grayish brown and olive gray loam with mottles. In some areas the soil is poorly drained, and the subsoil is grayer.

Included with this soil in mapping are small areas along Beaver Creek of soils that have a sandy loam subsoil underlain by sand and gravel at a depth of 40 inches or more.

Permeability is moderately slow, and surface runoff is slow. The available water capacity is high. The surface layer is 4 to 5 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

This soil is suited to cultivated crops, and in most areas it is cultivated.

This soil is in capability class I.

62C2—Storden loam, 5 to 9 percent slopes, moderately eroded. This is a moderately sloping, well drained soil on convex slopes on uplands. Slopes are typically short. The areas are rounded or long and range from 5 to 10 acres in size.

Typically, the surface layer is mixed with the substratum. It is pale brown and dark grayish brown, calcareous loam about 7 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam. In a few areas the surface layer is dark brown.

Permeability is moderate, and surface runoff is rapid. The available water capacity is high. The surface layer is less than 1 percent organic matter and has fair tilth. The substratum is very low in available phosphorus and potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. In some places, gullying is a hazard. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices. Short, irregular slopes complicate the task of providing adequate erosion control. Returning crop residue to the soil or regularly adding other organic matter helps improve fertility and tilth and increases water infiltration.

If this soil is used as pasture or hayland, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

62D2—Storden loam, 9 to 14 percent slopes, moderately eroded. This is a strongly sloping, well drained soil on convex side slopes on uplands. Slopes are typically short. The areas are long and narrow and range from 10 to 20 acres in size.

Typically, the plow layer is mixed with the substratum. It is brown, calcareous loam about 6 inches thick. The substratum to a depth of 60 inches is yellowish brown and light olive brown, mottled, calcareous loam. In a few uncultivated areas the surface layer is very dark grayish brown and is about 5 inches thick.

Permeability is moderate, and surface runoff is rapid. The available water capacity is high. The surface layer is less than 1 percent organic matter and has fair tilth. The substratum is very low in available phosphorus and potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, erosion is a hazard. In some places gullying is a hazard. Soil loss can be reduced significantly by a combination of conservation tillage, contour farming, crop rotation, or other conservation practices. In many places, short, irregular slopes complicate the task of providing adequate erosion control. Returning crop residue to the soil or regularly adding other organic matter helps improve fertility and tilth and increases water infiltration.

If this soil is used as pasture or hayland, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

62E2—Storden loam, 14 to 18 percent slopes, moderately eroded. This is a moderately steep, well drained soil on convex side slopes on uplands. Slopes are typically short. The areas are irregular in shape and range from 5 to 10 acres in size.

Typically, the plow layer is mixed with the substratum. It is brown and yellowish brown, calcareous loam about 8 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam. In a few uncultivated areas the surface layer is dark grayish brown and is about 4 or 5 inches thick.

Permeability is moderate, and surface runoff is rapid. The available water capacity is high. The surface layer is less than 1 percent organic matter and has fair tilth. The substratum is very low in available phosphorus and potassium.

This soil is suited to use as pasture, and in most areas it is in pasture. If the soil is used for cultivated crops, erosion is a very severe hazard. Soil loss can be reduced significantly by a combination of crop rotation, contour farming, conservation tillage, or other conservation practices. Leaving crop residue on the surface or regularly adding other organic matter helps improve fertility and tilth and increases water infiltration.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IVe.

62F—Storden loam, 18 to 25 percent slopes. This is a steep, well drained soil on convex side slopes of uplands. Slopes are typically short. The areas are irregular in shape and range from 5 to 10 acres in size.

Typically, the surface layer is dark grayish brown, calcareous loam about 6 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam.

Permeability is moderate, and surface runoff is rapid. The available water capacity is high. The surface layer is less than 1 percent organic matter. The substratum is very low in available phosphorus and potassium.

This soil is suited to use as pasture, and in most areas it is in permanent pasture. Because of steep slopes and

the severe hazard of erosion, this soil generally is not suited to cultivated crops. Soil loss can be reduced significantly if a good vegetative cover is maintained.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass VIe.

73D—Salida gravelly sandy loam, 5 to 14 percent slopes. This is a moderately to strongly sloping, excessively drained soil on stream terraces and upland knolls. The areas are irregular in shape and range from 5 to 15 acres in size.

Typically, the surface layer is mixed with the subsoil. It is dark brown gravelly sandy loam about 8 inches thick. The subsoil is brown gravelly loamy sand about 5 inches thick. The substratum to a depth of 60 inches is yellowish brown and pale brown, calcareous gravelly loamy sand. In some areas the soil is gravelly loamy sand or calcareous throughout or both.

Included with this soil in mapping are a few small areas of Storden soils that have more silt and clay throughout and a higher available water capacity. The included soils are in similar positions on the landscape and make up 2 to 5 percent of the map unit.

Permeability is very rapid, and surface runoff is slow. The available water capacity is very low. The surface layer is 1 to 2 percent organic matter and has fair tilth. The subsoil is very low in available phosphorus and potassium.

This soil is poorly suited to cultivated crops. However, in most areas it is cultivated. Because the soil is in small areas, it is managed with the adjacent soils. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by conservation tillage, contour farming, or a combination of these practices. Leaving crop residue on the surface or regularly adding other organic matter helps improve fertility and tilth and conserve moisture. This soil is very droughty, and crop yields are low in most years.

This soil is suited to use for pasture. If it is used as pasture, overgrazing increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IVe.

73F—Salida gravelly sandy loam, 14 to 25 percent slopes. This is a moderately steep to steep, excessively drained soil on upland knolls and ridgetops. The areas are irregular in shape and range from 5 to 10 acres in size.

Typically, the surface layer is very dark grayish brown and dark brown, calcareous gravelly sandy loam and loamy sand about 8 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous sand and coarse sand. In some areas the soil is gravelly throughout.

Included with this soil in mapping are a few areas of Storden and Zenor soils that have more silt and clay in the upper 20 to 30 inches and have a higher water-holding capacity. The included soils are in similar positions on the landscape and make up about 10 percent of the map unit.

Permeability is very rapid, and surface runoff is slow. The available water capacity is very low. The surface layer is 1 to 2 percent organic matter and has fair tilth. The substratum is very low in available phosphorus and potassium.

This soil is suited to use as pasture, and in most areas it is in pasture. This soil has severe limitations for use as cropland. It is droughty, and water erosion and soil blowing are hazards. Soil loss can be reduced significantly if a good vegetative cover is maintained.

If this soil is used as pasture, overgrazing increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is suitable as a source of sand.

This soil is in capability subclass VIe.

90—Okoboji mucky silt loam, 0 to 1 percent slopes. This is a level, very poorly drained soil in concave depressions on uplands. It is subject to ponding after heavy rains. The areas are rounded and range from 10 to 40 acres in size.

Typically, the surface layer is black mucky silt loam about 4 inches thick. The subsurface layer is black, mottled mucky silt loam and silty clay loam about 20 inches thick. The subsoil is about 18 inches thick. In the upper part it is gray and light olive gray, mottled silty clay loam, and in the lower part it is yellowish brown and olive, mottled silty clay loam. The substratum to a depth of 60 inches is olive gray, olive, and yellowish brown, mottled silty clay loam in the upper part and olive gray sand in the lower part. In some places, the surface layer is more than 20 percent organic matter. In some areas, free carbonates are on the surface.

Included with this soil in mapping are a few small areas of Harps soils that are highly calcareous throughout and have a very high concentration of free carbonates on the surface. The included soils are around the edges of the smaller depressions and make up 2 to 5 percent of the map unit.

Permeability is moderately slow, and surface runoff is slow to ponded. The available water capacity is very high. The surface layer is 8 to 16 percent organic matter and has fair tilth. The subsoil is very low in available phosphorus and potassium. The shrink-swell potential is high. This soil has a seasonal high water table.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated. Crops drown out in many places, and winterkilling of legumes is a hazard. This soil is slow to warm in spring, and because it is in low areas, crops are subject to damage by early frost.

This soil is suitable for use as habitat for wetland wildlife. Shallow water and wetland plants provide good habitat for wetland wildlife.

This soil is in capability subclass IIIw.

95—Harps loam, 0 to 2 percent slopes. This is a nearly level, poorly drained soil on upland flats and swales. The areas are typically narrow rings surrounding closed depressions about 2 to 5 acres in size. Where the closed depressions are numerous and small, the rings are connected, and the areas are irregular in shape and 5 to 25 acres in size (fig. 4).

Typically, the surface layer is black loam about 12 inches thick. The subsurface layer is very dark gray loam about 10 inches thick. The subsoil is gray, mottled loam about 32 inches thick. The substratum to a depth of about 60 inches is gray, mottled loam. This soil is calcareous throughout. In some areas the surface layer is dark and more than 24 inches thick.

Permeability is moderate, and surface runoff is slow. The available water capacity is high. The surface layer is about 6 or 7 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated. This soil is slow to warm in spring and tends to dry out cloddy and hard if worked when wet. The high content of lime restricts the availability of phosphorus, potassium, and other micronutrients. The potential for soybeans can be improved by planting varieties that are resistant to iron deficiencies or by special fertilization.

This soil is in capability subclass IIw.

107—Webster silty clay loam, 0 to 2 percent slopes. This is a nearly level, poorly drained soil on upland flats and drainageways. The areas are irregular in shape and range from 10 to 40 acres in size.

Typically, the surface layer is black silty clay loam about 12 inches thick. The subsurface layer is very dark gray silty clay loam about 6 inches thick. The subsoil is about 15 inches thick. It is very dark gray and olive gray clay loam and silty clay loam and has mottles. The substratum to a depth of 60 inches is mottled loam. In some areas, carbonates are within a depth of 20 inches.

Figure 4.—The light areas are Harps loam. They surround numerous small depressions.

Included with this soil in mapping along Beaver Creek are small areas of soils that have a sandy loam subsoil underlain by sand and gravel at a depth of 40 inches or more.

Permeability is moderate, and surface runoff is slow. The available water capacity is high. The surface layer is 6 to 8 percent organic matter and has fair tilth. The shrink-swell potential is moderate. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated. Tile drainage works well in this soil. The soil is slow to warm in spring and tends to dry out cloddy and hard if worked when wet.

If this soil is used as pasture, grazing when the soil is wet causes surface compaction and reduces infiltration. Restricting use during wet periods helps keep the pasture and soil in good condition.

This soil is in capability subclass IIw.

135—Coland clay loam, 0 to 2 percent slopes. This is a nearly level, poorly drained soil on first bottoms and low benches. It is subject to flooding. The areas are long and narrow and range from 20 to 60 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is black clay loam about 32 inches thick. The substratum to a depth of 60 inches is black clay loam and has mottles. In some areas sandy loam is below a depth of 40 inches.

Included with this soil in mapping are small areas of Calco soils that are calcareous throughout. The included soils are in similar landscape positions and make up about 5 percent of the map unit.

Permeability is moderate, and surface runoff is slow. The available water capacity is high. The surface layer is 6 to 8 percent organic matter and has good tilth. It has high shrink-swell potential. The subsoil is low in available phosphorus and very low in available potassium. This soil has a seasonal high water table.

This soil is suited to cultivated crops, if it is drained and protected from flooding and runoff. In most areas it is cultivated. Tile drainage works well in this soil if suitable outlets are available. This soil warms slowly in spring and tends to dry out cloddy and hard if worked when wet. Low-lying areas and old bayous tend to pond after flooding. Streambank cutting occurs in places.

If this soil is used as pasture, grazing when the soil is wet causes surface compaction and reduces infiltration. Restricting use during wet periods helps keep the pasture and soil in good condition.

This soil is in capability subclass IIw.

138B—Clarion loam, 2 to 5 percent slopes. This is a gently sloping, well drained soil on convex upland knolls. Slopes are typically short. The areas are irregular in shape and range from 10 to 50 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is brown loam about 4 inches thick. The subsoil is about 28 inches thick. It is dark brown and brown loam, grading to yellowish brown loam with depth. The substratum to a depth of about 60 inches is light yellowish brown to mottled, pale brown and strong brown, calcareous loam. In some areas carbonates are within 20 inches of the surface.

Included with this soil in mapping are small areas, along Beaver Creek, of soils that have a sandy loam subsoil underlain by sand and gravel at a depth of 40 inches or more.

Permeability is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is 3 to 4 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices.

This soil is in capability subclass IIe.

138C—Clarion loam, 5 to 9 percent slopes. This is a moderately sloping, well drained soil on knolls and convex side slopes along small streams and upland drainageways. Slopes are typically short. The areas are irregular in shape and range from 10 to 30 acres in size.

Typically, the surface layer is very dark brown loam about 6 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is brown loam about 22 inches thick. The substratum to a depth of about 60 inches is yellowish brown to mottled, pale brown and strong brown, calcareous loam. In some areas, carbonates are directly below the surface layer. Also, in some areas the substratum is sandy loam.

Permeability is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is 3 to 4 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices.

If this soil is used as pasture, overgrazing causes surface compaction and increased runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

138C2—Clarion loam, 5 to 9 percent slopes, moderately eroded. This is a moderately sloping, well

drained soil on knolls and convex side slopes that border streams and upland drainageways. Slopes are typically short. The areas are irregular in shape and range from 10 to 40 acres in size.

Typically, the surface layer is mixed brown and dark brown loam about 7 inches thick. The subsoil is about 17 inches thick. It is brown loam grading to yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown to mottled, pale brown and strong brown, calcareous loam. In some areas the soil is calcareous directly below the surface layer. In some areas the substratum is sandy loam.

Included with this soil in mapping are a few small areas of Storden soils that are calcareous throughout. The included soils are on high convex areas and make up 5 to 10 percent of the map unit.

Permeability is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is 2 to 3 percent organic matter and has fair tilth. However, it has a tendency to crust or puddle after hard rains because the surface layer is mixed with the subsoil. The subsoil is very low in available phosphorus and potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. This soil is moderately eroded. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by a combination of conservation tillage, contour farming, terraces, crop rotation, or other conservation practices. Returning crop residue or regularly adding other organic matter helps improve fertility, reduce crusting, and increase water infiltration.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

138D2—Clarion loam, 9 to 14 percent slopes, moderately eroded. This is a strongly sloping, well drained soil on convex side slopes of uplands. Slopes are typically short. The areas are irregular in shape and range from 5 to 15 acres in size.

Typically, the surface layer is mixed dark brown and dark yellowish brown loam about 7 inches thick. The subsoil is about 12 inches thick. It is dark yellowish brown loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In uncultivated areas, the surface layer is about 5 inches thick and is very dark grayish brown.

Included with this soil in mapping are a few small areas of Storden soils that are calcareous throughout. The included soils are on high convex areas and make up 5 to 10 percent of the map unit.

This soil has moderate permeability, and surface runoff is medium. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is 2 to 3 percent organic matter and has fair tilth. However, the surface layer has a tendency to crust or puddle after hard rains because it is mixed with the subsoil. The subsoil is very low in available phosphorus and potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. It is moderately eroded. Erosion is a hazard if the soil is cultivated. Soil loss can be reduced significantly by conservation tillage, contour farming, crop rotation, or a combination of these practices. Returning crop residue or regularly adding other organic matter helps improve fertility, reduce crusting, and increase water infiltration.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

167—Ames silt loam, 0 to 1 percent slopes. This is a level, very poorly drained soil in concave upland depressions. The areas are rounded and range from 2 to 5 acres in size.

Typically, the surface layer is very dark brown silt loam about 3 inches thick. The subsurface layer is dark gray and light brownish gray silt loam about 14 inches thick. The subsoil is about 36 inches thick. It is gray and grayish brown, mottled, very firm clay loam and clay. The substratum to a depth of 60 inches is olive gray and mottled, gray and strong brown loam. In cultivated areas the surface and subsurface layers are mixed.

Permeability is very slow, and surface runoff is slow to ponded. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is less than 1 percent organic matter and has fair tilth. The surface has a tendency to crust or puddle after hard rains. The subsoil has a high shrink-swell potential. It is low in available phosphorus and very low in available potassium. This soil has a seasonal high water table.

This soil is suited to pasture and timber, and in most areas it is in pasture or timber. The soil is slow to warm in spring, and because it is in low areas, it is subject to damage by early frost.

If this soil is used as pasture, overgrazing or grazing when the soil is wet causes surface compaction and reduces infiltration. Proper stocking rates, pasture rotation, and restricting use during wet periods help keep the pasture and soil in good condition.

This soil is in capability subclass IIIw.

168B—Hayden loam, 2 to 5 percent slopes. This is a gently sloping, well drained soil on convex upland ridgetops. Slopes are typically short. The areas are irregular and narrow in shape and range from 10 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loam about 2 inches thick. The subsurface layer is dark

grayish brown loam about 8 inches thick. The subsoil is about 32 inches thick. It is dark yellowish brown, yellowish brown, and light olive brown, mottled, firm clay loam and loam. The substratum to a depth of 60 inches is light olive brown, calcareous loam that has strong brown mottles. In cultivated areas, the surface layer is dark grayish loam about 8 inches thick.

Permeability is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is 1 to 2 percent organic matter and has fair tilth. The surface has a tendency to crust or puddle after hard rains. The subsoil has a moderate shrink-swell potential. It is medium in available phosphorus and low in available potassium.

In many areas this soil is cultivated. In about 30 percent of the remaining areas the soil is in wooded pasture. Erosion is a hazard if this soil is cultivated. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices. Returning crop residue or regularly adding other organic matter helps improve fertility, reduce crusting, and increase water infiltration.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIe.

168C—Hayden loam, 5 to 9 percent slopes. This is a moderately sloping, well drained soil on convex upland ridgetops that are generally near major streams. Slopes are typically short. The areas are irregular and narrow in shape and range from 5 to 10 acres in size.

Typically, the surface layer is very dark grayish brown loam about 3 inches thick. The subsurface layer is dark grayish brown loam about 8 inches thick. The subsoil is about 30 inches thick. It is yellowish brown loam and firm clay loam. The substratum to a depth of 60 inches is yellowish brown and brownish yellow, calcareous loam. In cultivated areas, the surface layer is dark grayish brown and dark brown loam about 8 inches thick.

Permeability is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is 1 to 2 percent organic matter and has fair tilth. The surface has a tendency to crust or puddle after hard rains. The subsoil is medium in available phosphorus and is low in available potassium.

In most areas this soil is in wooded pasture. It is suited to cultivated crops if the trees are cleared. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by a combination of conservation tillage, contour farming, terraces, crop rotation, or other conservation practices. Returning crop residue helps maintain good tilth and increases water infiltration.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

168C2—Hayden loam, 5 to 9 percent slopes, moderately eroded. This is a moderately sloping, well drained soil on convex upland ridgetops and side slopes that are generally near major streams. Slopes are typically short. The areas are irregular in shape and range from 10 to 20 acres in size.

Typically, the surface layer is mixed with the subsurface layer and the subsoil. It is dark grayish brown and dark brown loam about 8 inches thick. The subsoil is about 30 inches thick. In the upper part it is dark yellowish brown, mottled, firm clay loam, and in the lower part it is yellowish brown, mottled, firm clay loam. The substratum to a depth of 60 inches is light gray and light yellowish brown, calcareous loam that has mottles. In uncultivated areas, the surface layer is very dark grayish brown loam about 3 inches thick.

Permeability is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is less than 1 percent organic matter and has fair tilth. The surface has a tendency to crust or puddle after hard rains. The subsoil is medium in available phosphorus and low in available potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. However, it is moderately eroded. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by a combination of conservation tillage, contour farming, terraces, crop rotation, or other conservation practices. Returning crop residue or regularly adding other organic matter helps improve fertility, reduce crusting, and increase water infiltration.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

168D2—Hayden loam, 9 to 14 percent slopes, moderately eroded. This is a strongly sloping, well drained soil on upland side slopes that are generally near major streams. Slopes are typically short. The areas are irregular in shape and range from 5 to 10 acres in size.

Typically, the surface layer is mixed with the subsurface layer and the subsoil. It is dark brown loam about 6 inches thick. The subsoil is about 24 inches thick. In the upper part it is brown and yellowish brown clay loam, and in the lower part it is yellowish brown and light olive brown, firm clay loam. The substratum to a depth of 60 inches is light olive brown, calcareous loam with mottles. In some forested areas the surface and subsurface layers have a combined thickness of 5 inches.

Included with this soil in mapping are a few small areas of Storden soil that is calcareous throughout. The included soil is on south- and west-facing slopes and makes up 5 to 10 percent of the map unit.

Permeability is moderate, and surface runoff is rapid. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is less than 1 percent organic matter and has poor tilth. The subsoil is medium in available phosphorus and low in available potassium.

In most areas this soil is in pasture or trees. In many of these areas the soil was once used for cultivated crops. This soil is moderately eroded. If it is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by a combination of conservation tillage, contour farming, crop rotation, or other conservation practices. Returning crop residue or regularly adding other organic matter helps improve fertility, reduce crusting, and increase water infiltration.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

168E—Hayden loam, 14 to 18 percent slopes. This is a moderately steep, well drained soil on upland side slopes that are generally near major streams. Slopes are typically short. The areas are irregular in shape and range from 5 to 10 acres in size.

Typically, the surface layer is very dark grayish brown loam about 2 inches thick. The subsurface layer is brown loam about 3 inches thick. The subsoil is about 17 inches thick. It is brown loam grading with depth to yellowish brown, mottled clay loam. The substratum to a depth of 60 inches is light yellowish brown, mottled, calcareous loam. In some areas on the lower slopes, the lower part of the substratum is firm heavy clay loam.

Included with this soil are a few small areas of Storden soils that have less clay and are calcareous throughout. The included soils are on south- and west-facing slopes and make up 5 to 10 percent of the map unit.

Permeability is moderate, and surface runoff is rapid. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is 1 to 2 percent organic matter and has fair tilth. The subsoil is medium in available phosphorus and low in available potassium.

This soil is suited to use as pasture, and in most areas it is in pasture. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by a combination of crop rotation, contour farming, conservation tillage, or other conservation practices. Returning crop residue or regularly adding other organic matter helps improve fertility and tilth and increase water infiltration.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IVe.

203—Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This is a nearly level, somewhat poorly drained soil on stream benches and terraces. The areas are irregular in shape and range from 2 to 20 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black and very dark brown loam about 16 inches thick. The subsoil is about 11 inches thick. It is dark grayish brown sandy loam and loam. The substratum to a depth of about 60 inches is dark grayish brown, dark yellowish brown, and brown coarse sand. In some areas, coarse sand is at a depth of 24 inches. In some areas, the subsoil is sandy loam, and the depth to sand and gravel is more than 40 inches.

Permeability is moderate in the upper part and very rapid in the underlying coarse material. Surface runoff is slow. The available water capacity is moderate. The surface layer is 4 to 5 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

This soil is suited to cultivated crops, and in most areas it is cultivated. Generally, the available water is adequate. However, in periods of low rainfall the soil is droughty because of the underlying sand and gravel.

This soil is in capability class I.

221—Palms muck, 0 to 1 percent slopes. This is a level, very poorly drained soil in concave depressions on upland flats and swales (fig. 5). It is subject to ponding after heavy rains. The areas are rounded and range from 5 to 20 acres in size.

Typically, the surface layer is black muck about 15 inches thick. The subsurface layer is black muck about 21 inches thick. The layer below the organic material is black silt loam about 20 inches thick. The substratum to a depth of about 60 inches is gray silt loam. In some areas the organic material extends to a depth of as much as 20 feet.

Permeability is moderately rapid in the upper part and moderate in the lower part. Surface runoff is very slow. The available water capacity is very high. The surface layer is 20 to 40 percent organic matter. The subsoil is low in available phosphorus and very low in available potassium. This soil has a seasonal high water table. It dries out more slowly than the adjacent soils, and therefore tillage is delayed.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated. This soil is very wet, and in many areas it tends to pond in spring or during heavy rains. Surface intakes to tile drains are desirable. Crops drown out in many places, and winterkilling of legumes is a hazard. This soil is slow to warm in spring, and because it is in low areas, crops are subject to damage

Figure 5.—An area of Palms muck that can only be cultivated during periods of low rainfall.

by early frost. Returning crop residue helps maintain good tilth and increase water infiltration.

If this soil is used as pasture, grazing when the soil is wet causes the surface to become rough. Deferring grazing and restricting use during wet periods help keep the pasture and soil in good condition.

This soil is suitable for use as habitat for wetland wildlife. Shallow water and wetland plants provide good habitat for wetland wildlife.

This soil is in capability subclass IIIw.

224—Linder sandy loam, 0 to 2 percent slopes. This is a nearly level, somewhat poorly drained soil on stream benches and terraces. The areas are irregular in shape and range from 2 to 15 acres in size.

Typically, the surface layer is black sandy loam about 8 inches thick. The subsurface layer is black and very dark gray sandy loam about 11 inches thick. The subsoil is about 15 inches thick. In the upper part it is very dark grayish brown, friable sandy loam, in the middle part it is dark grayish brown, very friable sandy loam, and in the lower part it is grayish brown, loose gravelly loamy sand. The substratum to a depth of 60 inches is grayish brown gravelly sand. In some areas the upper part of the subsoil has less sand.

Permeability is moderately rapid in the upper part and rapid in the underlying coarse material. Surface runoff is slow. The available water capacity is low. The surface layer is 4 to 5 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

This soil is suited to cultivated crops, and in most areas it is cultivated. Because of the underlying sand and gravel, the soil is droughty.

This soil has good potential as a source of sand, provided the sand layer is thick enough.

This soil is in capability subclass IIs.

236B—Lester loam, 2 to 5 percent slopes. This is a gently sloping, well drained soil on convex upland knolls and ridgetops. Slopes are typically short. The areas are irregular in shape and range from 5 to 20 acres in size.

Typically, the surface layer is very dark grayish brown loam about 7 inches thick. The subsoil is about 25 inches thick. In the upper part it is brown loam, and in the lower part it is dark yellowish brown and yellowish brown, mottled, firm clay loam. The substratum to a depth of 60 inches is brown, mottled loam and clay loam.

Permeability is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is 2 to 3 percent organic matter and has good tilth. The subsoil is medium in available phosphorus and very low in available potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIe.

236C2—Lester loam, 5 to 9 percent slopes, moderately eroded. This is a moderately sloping, well drained soil on convex upland knolls and ridgetops. Slopes are typically short. The areas are irregular in shape and range from 5 to 20 acres in size.

Typically, the surface layer is mixed dark brown and brown loam about 6 inches thick. The subsoil is about 21 inches thick. In the upper part it is brown clay loam, in the middle part it is dark yellowish brown clay loam, and in the lower part it is yellowish brown loam. The substratum to a depth of 60 inches is yellowish brown loam. In uncultivated areas, the surface layer is about 5 inches thick and is very dark gray.

Permeability is moderate, and the surface runoff is medium. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is 1 to 2 percent organic matter and has fair tilth. The surface tends to crust after heavy rains. The subsoil is medium in available phosphorus and very low in available potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. However, it is moderately eroded. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by a combination of conservation tillage, contour farming, terraces, crop rotation, or other conservation practices. Returning crop residue or regularly adding other organic matter helps improve fertility, reduce crusting, and increase water infiltration.

This soil is in capability subclass IIIe.

259—Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This is a nearly level, poorly drained soil on stream terraces. The areas are irregular in shape and range from 10 to 30 acres in size.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is black and very dark gray loam about 11 inches thick. The subsoil is about 19 inches thick. In the upper part it is olive gray, mottled clay loam, and in the lower part it is mixed olive gray, olive, and gray sandy clay loam. The substratum to a depth of 60 inches is gray and light olive gray gravelly sand. In some areas, the subsoil is sandy loam, and the depth to sand and gravel is more than 40 inches. In some other areas, coarse sand is at a depth of 24 inches.

Permeability is moderate in the surface layer and subsoil and rapid in the substratum. Surface runoff is slow. The available water capacity is moderate. The surface layer is 6 to 8 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated. Tile drainage works well in this soil, but ditches may cave in when the tile is installed. This soil is slow to warm in spring and tends to dry out cloddy and hard if worked when wet.

If this soil is used as pasture, grazing when the soil is wet causes surface compaction and reduces infiltration. Restricting use during wet periods helps keep the pasture and soil in good condition.

This soil has good potential as a source of sand, provided the sand layer is thick enough.

This soil is in capability subclass IIw.

307—Dundas silt loam, 0 to 2 percent slopes. This is a nearly level, poorly drained soil on concave upland swales and heads of drainageways. The areas are elongated and range from 2 to 10 acres in size.

Typically, the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is grayish brown silt loam about 3 inches thick. The subsoil is about 25 inches thick. In the upper part it is grayish brown, mottled, firm silty clay loam, and in the lower part it is olive gray and olive, mottled, very firm clay loam. The substratum to a depth of 60 inches is light olive gray and brownish yellow, mottled loam.

Permeability is moderately slow, and surface runoff is slow. The available water capacity is high. Shrink-swell potential is moderate. The surface layer is generally acid unless lime has been added. It is 2 to 3 percent organic

matter and has fair tilth. The surface tends to crust or puddle after heavy rainfall. The subsoil is medium in available phosphorus and is low in available potassium. This soil has a seasonal high water table.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated. Because the soil is in small areas, it is generally managed with the adjacent soils. This soil has poor potential for trees. In some slightly depressed areas the soil tends to pond during periods of heavy rain. Surface intakes to tile drains are desirable. Drowning out of crops and winterkilling of legumes are hazards. This soil is slow to warm in spring and tends to dry out cloddy and hard if worked when wet. Tile drains work only fairly well in this soil because of the moderately slow permeability of the subsoil. Returning crop residue helps improve tilth and increase water infiltration.

If this soil is used as pasture, grazing when the soil is wet causes surface compaction and reduces infiltration. Restricting use during wet periods helps keep the pasture and soil in good condition.

This soil is in capability subclass IIIw.

308—Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This is a nearly level, well drained soil on terraces and glacial outwash areas. The areas are irregular in shape and range from 5 to 20 acres in size.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown sandy loam about 15 inches thick. The subsoil is about 12 inches thick. In the upper part it is brown sandy loam, and in the lower part it is brown and dark yellowish brown loamy sand. The substratum to a depth of 60 inches is variegated, calcareous sand and gravel. In some areas, sand and gravel are at a depth of 24 inches. In some areas, the subsoil is sandy loam, and the depth to sand and gravel is more than 40 inches.

Included with this soil in mapping are a few small areas of Ridgeport soils that have more sand in the surface layer and a lower available water capacity. The included soils are in similar landscape positions and make up about 5 percent of the map unit.

Permeability is moderately rapid in the upper part and rapid in the lower part. Surface runoff is medium. The available water capacity is moderate. The surface layer is generally acid unless lime has been added. It is 2 to 3 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. Generally, the available water is adequate. However, in periods of low rainfall the soil is droughty because of the underlying sand and gravel.

If this soil is used as pasture, overgrazing causes surface compaction and decreased infiltration. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil has fair to good potential as a source of sand and gravel, provided the sand and gravel layer is thick enough.

This soil is in capability subclass IIs.

308B—Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes. This is a gently sloping, well drained soil on terraces and glacial outwash areas. The areas are irregular in shape and range from 5 to 10 acres in size.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 13 inches thick. The subsoil is about 18 inches thick. It is brown loam grading to sandy loam with depth. The substratum to a depth of 60 inches is variegated, calcareous sand. In some areas, sand and gravel are at a depth of 24 inches. In some areas, the subsoil is sandy loam, and the depth to sand and gravel is more than 40 inches.

Included with this soil in mapping are a few small areas of Ridgeport soils that have more sand in the surface layer and a lower available water capacity. The included soils are in similar landscape positions and make up about 10 percent of the map unit.

Permeability is moderately rapid in the upper part and rapid in the lower part. Surface runoff is medium. The available water capacity is moderate. The surface layer is generally acid unless lime has been added. It is 2 to 3 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices. Because of the underlying sand and gravel, cuts for terracing should be kept to a minimum to avoid excessive reduction of the available water capacity. This soil is somewhat droughty when rainfall is below normal.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil has fair to good potential as a source of sand and gravel, provided the sand and gravel layer is thick enough.

This soil is in capability subclass IIe.

325—Le Sueur loam, 0 to 2 percent slopes. This is a nearly level, somewhat poorly drained soil on slightly convex upland rises. The areas are irregular in shape and range from 5 to 15 acres in size.

Typically, the surface layer is black and very dark grayish brown loam about 8 inches thick. The subsoil is about 32 inches thick. It is dark grayish brown, firm clay loam that has mottles. The substratum to a depth of 60 inches is grayish brown loam that has strong brown mottles.

Included with this soil in mapping are a few small areas of Webster soils that are wetter than the Le Sueur soil. The included soils are in drainageways and make up about 5 percent of the map unit.

Permeability is moderate, and surface runoff is slow. The available water capacity is high. The surface layer is 2 to 4 percent organic matter and has good tilth. The subsoil is medium in available phosphorus and very low in available potassium. This soil has a seasonal high water table.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated.

This soil is in capability class I.

335—Harcot loam, 0 to 2 percent slopes. This is a nearly level, poorly drained soil on flats and swales of stream terraces in the western part of the county. It is rarely flooded. The areas are typically narrow rings around closed depressions about 2 to 5 acres in size. Where the closed depressions are very numerous and small, the rings of Harcot soil are connected, and the areas are irregular in shape and 5 to 25 acres in size.

Typically, the surface layer is very dark gray loam about 7 inches thick. The subsurface layer is also very dark gray loam about 7 inches thick. The subsoil is about 20 inches thick. In the upper part it is dark grayish brown, very friable sandy clay loam, and in the lower part it is olive and olive gray gravelly sandy clay loam. The substratum to a depth of 60 inches is light olive gray gravelly sand and olive gravelly loamy sand. This soil is calcareous throughout. In some areas, sand or gravel is at a depth of 40 inches or more.

Permeability is moderate in the upper part and very rapid in the underlying coarse material. Runoff is slow, and the soil tends to pond in some places. The available water capacity is moderate. The surface layer is about 6 to 7 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated. In some slightly depressed areas the soil tends to pond during periods of heavy rainfall. This soil is slow to warm in spring and tends to dry out cloddy and hard if worked when wet. The high content of lime restricts the availability of phosphorus, potassium, and most micronutrients.

This soil has good potential as a source of sand, provided the sand layer is thick enough.

This soil is in capability subclass IIw.

354—Palms muck, ponded, 0 to 1 percent slopes. This is a level, very poorly drained soil in wet, ponded areas covered mainly with grasses, cattails, rushes, and other wetland plants (fig. 6). It is in closed depressions. The areas are rounded and range from 2 to 10 acres in size.

Typically, the surface layer is black organic material about 10 inches thick. The subsurface layer is black organic material about 30 inches thick. The substratum to a depth of about 60 inches is black or very dark gray silty clay loam that has mottles and is high in organic matter. In some areas the organic matter is as much as 20 feet thick.

Permeability is moderately rapid in the upper part and moderate in the lower part. Runoff is slow. The soil is covered with a few inches of standing water in most years. The surface layer is 40 to 90 percent organic matter.

Nearly all of this land has natural vegetation of sedges, cattails, and swampgrasses. This soil has good potential for use as habitat for wetland wildlife. Waterfowl, muskrats, and other wildlife find food and nesting places in or around the edges of areas of this soil. Some attempts to drain the soil have been made, but such attempts have been expensive and only partially successful. Generally, leaving this soil in natural vegetation for use as wildlife habitat is the most appropriate use.

This soil is in capability subclass VIIw.

355—Luther loam, 0 to 2 percent slopes. This is a nearly level, somewhat poorly drained soil on flat to slightly convex areas of uplands. Slopes are typically short. The areas are irregular in shape and range from 10 to 20 acres in size.

Typically, the surface layer is very dark grayish brown loam about 4 inches thick. The subsurface layer is dark grayish brown loam about 11 inches thick. The subsoil is about 20 inches thick. In the upper part it is dark grayish brown, mottled, firm clay loam, and in the lower part it is grayish brown, mottled, firm clay loam. The substratum to a depth of 60 inches is mottled grayish brown and yellowish brown, calcareous loam. In cultivated areas, the surface layer is dark grayish brown loam about 8 inches thick.

Permeability is moderately slow, and surface runoff is slow. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is 2 to 3 percent organic matter and has good tilth. However, the surface tends to crust or puddle after hard rains. The subsoil is medium in available phosphorus and low in available potassium. This soil has a seasonal high water table.

In many areas this soil is cultivated. In some areas it remains in native vegetation, and in other areas it is commonly used for pasture.

If this soil is used as pasture, grazing when the soil is wet causes surface compaction and decreases infiltration. Restricting use during wet periods helps keep the pasture and soil in good condition.

This soil is in capability class I.

356G—Hayden-Storden loams, 25 to 50 percent slopes. This map unit consists of very steep, well drained soils on upland side slopes adjacent to major streams (fig. 7). In most areas the soils are dissected by

Figure 6.—An area of Palms muck, ponded, along Frog Creek in the southwest corner of the county.

gullies and deep drainageways. The areas range from 20 to several hundred acres in size. They are about 35 to 45 percent Hayden loam and 35 to 45 percent Storden loam. The Hayden soils are on north- and east-facing side slopes and ridgetops. The Storden soils are on west- and south-facing slopes. Areas of the two soils are so intricately mixed that it was not practical to map them separately.

Typically, the surface layer of the Hayden soil is very dark gray loam about 2 inches thick. The subsurface layer is brown loam about 6 inches thick. The subsoil is about 12 inches thick. In the upper part it is brown clay loam, and in the lower part it is yellowish brown clay loam. The substratum to a depth of 60 inches is yellowish brown, calcareous loam with strong browm mottles.

Typically, the surface layer of the Storden soil is brown loam about 4 inches thick. The substratum to a depth of 60 inches is yellowish brown, mottled, calcareous loam.

Included with these soils in mapping are some soils that are gravelly throughout and have a lower available water capacity. The included soils are on side slopes and are intermingled with the Storden soil. They make up about 10 percent of the map unit.

Permeability is moderate, and surface runoff is rapid. The available water capacity is high. The surface layer of the Hayden soil is generally acid. It is about 1 to 2 percent organic matter. The subsoil of the Hayden soil is medium in available phosphorus and low in available potassium. The surface layer of the Storden soil is 1 to 2 percent organic matter. The subsoil is very low in available phosphorus and potassium.

In most areas these soils are in woodland or permanent pasture. The soils are not suited to cultivation. In a few areas the soils have been cleared for use as pasture. They are susceptible to severe erosion if not protected. Erosion can be kept to a minimum by maintaining good vegetative cover.

These soils are in capability subclass VIIe.

383—Marna silty clay loam, 0 to 2 percent slopes. This is a nearly level, poorly drained soil on uplands. The areas are irregular in shape and range from 30 to 60 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray, firm and very firm silty clay loam about 14 inches thick. The subsoil is about 24 inches thick. In the upper part it is dark gray, very firm silty clay, in the middle part it is olive gray, mottled very firm silty clay, and in the lower part it is olive gray and olive, mottled, firm silty clay loam. The substratum to a depth of 60 inches is multicolored, calcareous clay loam.

Permeability is slow, and surface runoff is slow. The available water capacity is high. The surface layer is 6 to 8 percent organic matter and has fair tilth. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated. Tile drains are used in this soil, but they are not very effective because of the slow permeability in the subsoil. This soil is slow to warm in spring and tends to dry out cloddy and hard if worked when wet.

This soil is in capability subclass IIw.

385B—Guckeen clay loam, 1 to 4 percent slopes. This is a very gently sloping and gently sloping, somewhat poorly drained soil on convex upland rises. Slopes are typically short. The areas are irregular in shape and range from 5 to 15 acres in size.

Figure 7.—This area of Hayden-Storden loams, 25 to 50 percent slopes, is suited to use as woodland and as habitat for woodland wildlife.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is very dark gray silty clay loam about 10 inches thick. The subsoil is about 23 inches thick. In the upper part it is dark grayish brown silty clay loam, in the middle part it is dark grayish brown, mottled, firm and very firm silty clay loam, and in the lower part it is grayish brown, mottled loam. The substratum to a depth of 60 inches is grayish brown and yellowish brown, mottled, calcareous loam. In some areas the subsoil is browner.

Permeability is slow, and surface runoff is medium. The available water capacity is high. The surface layer is 4 to 6 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, or crop rotation.

This soil is in capability subclass IIe.

444C—Jacwin loam, 3 to 9 percent slopes. This is a gently and moderately sloping, somewhat poorly drained soil on concave terraces. The areas are irregular in shape and range from 2 to 40 acres in size.

Typically, the surface layer is black loam about 7 inches thick. The subsurface layer is black loam about 6 inches thick. The subsoil is about 20 inches thick. In the upper part it is dark grayish brown sandy clay loam, in the middle part it is light olive brown sandy clay loam, and in the lower part it is mottled, grayish brown and strong brown firm clay. The substratum to a depth of 60 inches is multicolored clayey shale. Depth to shale is variable.

Included with this soil in mapping are a few small areas of Moingona soils that are more than 60 inches to shale. The included soils are on foot slopes and make up 5 to 10 percent of the map unit.

Permeability is moderate in the loamy material and very slow in the shale material. Surface runoff is medium. The available water capacity is moderate. The surface layer is 3 to 4 percent organic matter and generally has good tilth. The subsoil is low in available phosphorus and potassium. This soil has a seasonal high water table.

This soil is suited to cultivated crops, and in most areas it is cultivated. It is subject to runoff from the adjacent uplands. In places, diversion terraces can be used to protect the soil from runoff and prevent the resulting rills and gullies. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by a combination of conservation tillage, contour farming, terraces, crop rotation, or other conservation practices.

If this soil is used as pasture, grazing when the soil is wet causes surface compaction and increases runoff. Restricting use during wet periods helps keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

485—Spillville loam, 0 to 2 percent slopes. This is a nearly level, somewhat poorly drained soil on bottom lands and upland drainageways. It is subject to flooding. The areas are irregular in shape and range from 5 to 10 acres in size.

Typically, the surface layer is very dark brown loam about 9 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 43 inches thick. The substratum to a depth of 60 inches is dark brown loam. In some areas, the thickness of the surface layer combined with that of the subsurface layer is less than 24 inches.

Permeability is moderate, and surface runoff is slow. The available water capacity is high. The surface layer is 4 to 5 percent organic matter and has good tilth. The subsoil is low in available phosphorus and very low in available potassium. This soil has a seasonal high water table.

This soil is suited to cultivated crops, and in most areas it is cultivated.

If the soil is used as pasture, overgrazing or grazing when the soil is wet causes surface compaction and reduces infiltration. Proper stocking rates, pasture rotation, deferring grazing, and restricting use during wet periods help keep the pasture and soil in good condition.

This soil is in capability subclass IIw.

485B—Spillville loam, 2 to 5 percent slopes. This is a gently sloping, moderately well drained soil on concave foot slopes along well defined upland drainageways and swales. Slopes are typically short. The areas are long and narrow and range from 5 to 10 acres in size.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 28 inches thick. The subsoil is about 24 inches thick. It is dark grayish brown loam that has mottles in the lower part. In some areas, the surface layer is thinner, and the soil is wetter.

Included with this soil in mapping are a few small areas of Terril soils which are better drained. They are upslope from the Spillville soil and make up 10 to 15 percent of the map unit.

Permeability is moderate, and surface runoff is slow. This soil receives runoff from the soils upslope. The available water capacity is high. The surface layer is 4 to 5 percent organic matter and has good tilth. The subsoil is low in available phosphorus and vey low in available potassium. This soil has a seasonal high water table.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, erosion is a hazard. In places, diversion terraces can be used to protect the soil from runoff.

This soil is in capability subclass IIe.

507—Canisteo silty clay loam, 0 to 2 percent slopes. This is a nearly level, poorly drained soil in

swales on uplands. The areas are irregular in shape and generally are more than 40 acres in size.

Typically, the surface layer is black, calcareous silty clay loam about 8 inches thick. The subsurface layer is black and very dark gray clay loam about 10 inches thick. The subsoil is about 18 inches thick. In the upper part it is dark gray and olive gray, mottled, calcareous clay loam, and in the lower part it is pale olive, mottled, calcareous loam. The substratum to a depth of 60 inches is light olive gray, mottled, calcareous loam. In some areas the soil does not have free carbonates in the upper 10 inches.

Included with this soil in mapping are small areas along Beaver Creek of soils that have a sandy loam subsoil underlain by sand and gravel at a depth of 40 inches or more.

Permeability is moderate, and surface runoff is slow. The available water capacity is high. The surface layer is 6 to 8 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated. In some slightly depressed areas the soil tends to pond during periods of heavy rainfall. This soil is slow to warm in spring and tends to dry out cloddy and hard if worked when wet.

This soil is in capability subclass IIw.

511—Blue Earth mucky silt loam, 0 to 1 percent slopes. This is a level, very poorly drained soil in concave upland depressions. The soil ponds after heavy rainfall. The areas are round and irregular in shape and range from 5 to 25 acres in size.

Typically, the surface layer is black mucky silt loam about 8 inches thick. The subsurface layer is about 32 inches thick. In the upper part it is black mucky loam, and in the lower part it is black loam and silt loam. The subsoil is about 4 inches thick. It is black, mottled silty clay loam. The substratum to a depth of 60 inches is gray, mottled silty clay loam. This soil is calcareous throughout.

Included with this soil in mapping are a few small areas of Harps soils that are better drained and have more lime. The Harps soils are around the edges of some depressions and make up about 2 to 5 percent of the map unit.

Permeability is moderate, and surface runoff is very slow or ponded. The available water capacity is very high. The surface layer contains 20 to 40 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated. The soil is very wet, and in many areas it tends to pond in spring or during heavy rains. Surface intakes to tile drains are desirable. Crops drown out in many places, and winterkilling of legumes is a hazard. This soil is slow to warm in spring, and because it is in low areas, crops are subject to damage by early frost.

This soil is suitable for use as habitat for wetland wildlife. Shallow water and wetland plants provide good habitat for wetland wildlife.

This soil is in capability subclass IIIw.

536—Hanlon fine sandy loam, 0 to 2 percent slopes. This is a nearly level, moderately well drained soil on natural levees and bottom lands. This soil is subject to flooding. The areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black fine sandy loam about 8 inches thick. The subsurface layer is about 35 inches thick. In the upper part it is very dark brown fine sandy loam, and in the lower part it is very dark grayish brown fine sandy loam. The subsoil to a depth of about 60 inches is dark brown fine sandy loam.

Included with this soil in mapping are a few small areas of Spillville soils that have more clay throughout. The included soils are in lower areas and make up about 10 percent of the map unit.

Permeability is moderately rapid, and surface runoff is slow. The available water capacity is high. The surface layer is 3 to 4 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, minimum tillage helps prevent excessive soil loss from soil blowing and conserves moisture. This soil is somewhat droughty during periods of low rainfall or when rainfall is not timely. In some areas diversions help prevent overflow and siltation from higher elevations.

Where this soil is within the flood pool of Saylorville Lake it may be subject to flooding of long duration.

This soil is in capability subclass IIs.

559—Talcot clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. This is a nearly level, poorly drained soil on stream terraces and glacial outwash areas. The areas are irregular in shape and range from 15 to 30 acres in size.

Typically, the surface layer is black calcareous clay loam about 7 inches thick. The subsurface layer is black calcareous clay loam about 16 inches thick. The subsoil is about 15 inches thick. In the upper part it is dark gray and olive gray, mottled, calcareous, firm clay loam, and in the lower part it is olive gray, mottled, calcareous gravelly sandy clay loam. The substratum to a depth of 60 inches is olive gray and pale olive, calcareous coarse sand and fine gravel. In some areas the soil is shallower to sand and gravel. In some areas, the subsoil is sandy loam, and the depth to sand and gravel is more than 40 inches.

Permeability is moderate in the surface layer and subsoil and rapid in the substratum. Surface runoff is slow. The available water capacity is moderate. The

surface layer is 6 to 8 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated. Tile drainage works well in this soil, but ditches may cave in when the tile is installed. This soil is slow to warm in spring and tends to dry out cloddy and hard if worked when wet.

This soil has good potential as a source of sand, provided the sand layer is thick enough.

This soil is in capability subclass IIw.

566B—Moingona loam, 1 to 5 percent slopes. This is a very gently and gently sloping, moderately well drained soil on alluvial fans and foot slopes along major streams (fig. 8). The areas are elongated or fan shaped and range from 5 to 40 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is about 28 inches thick. The upper part is brown loam, and the lower part is brown sandy loam. The substratum to a depth of about 60 inches is brown sandy loam. In some areas the subsurface layer is dark grayish brown.

Included with this soil in mapping are a few small areas where the soils are underlain by a dense clay substratum at a depth of 50 to 60 inches. This substratum causes the soil to drain more slowly. The included soils are in similar positions on the landscape and make up about 5 percent of the map unit.

Figure 8.—In most areas, Moingona loam is suitable for cultivation and is used for crops. Hayden-Storden loams are on the wooded side slopes.

Permeability is moderate, and surface runoff is slow. The available water capacity is high. The surface layer is 2 to 4 percent organic matter and has good tilth. The subsoil is medium in available phosphorus and is very low in available potassium. This soil has a seasonal high water table.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, or crop rotation.

This soil is in capability subclass IIe.

566C—Moingona loam, 5 to 9 percent slopes. This is a moderately sloping, moderately well drained soil on alluvial fans and foot slopes along major streams. The areas are elongated or fan shaped and range from 5 to 40 acres in size.

Typically, the surface layer is very dark brown loam about 7 inches thick. The subsurface layer is very dark grayish brown loam about 5 inches thick. The subsoil is about 36 inches thick. It is brown, friable loam and clay loam in the upper part and brown and dark yellowish brown, friable clay loam in the lower part. The substratum to a depth of 60 inches is brown and olive brown loam. In some areas there is no subsurface layer.

Permeability is moderate, and surface runoff is medium. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is 2 to 4 percent organic matter and has good tilth. The subsoil is medium in available phosphorus and very low in available potassium. This soil has a seasonal high water table.

This soil is suited to cultivated crops, and in most areas it is cultivated. It is subject to runoff from the adjacent uplands. In places, diversion terraces can be used to protect the soil from runoff and thus prevent rills and gullies. If this soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by a combination of conservation tillage, contour farming, terraces, crop rotation, or other conservation practices.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

566D—Moingona loam, 9 to 14 percent slopes. This is a strongly sloping, moderately well drained soil on foot slopes along major streams. The areas are elongated and range from 5 to 25 acres in size.

Typically, the surface layer is very dark grayish brown loam about 7 inches thick. The subsoil is about 25 inches thick. It is brown and dark yellowish brown clay loam. The substratum to a depth of about 60 inches is brown and olive brown loam. In some areas there is a dark grayish brown subsurface layer.

Permeability is moderate, and surface runoff is slow. The available water capacity is high. The surface layer is generally acid unless lime has been added. It is 2 to 4 percent organic matter and has good tilth. The subsoil is medium in available phosphorus and very low in available potassium. This soil has a seasonal high water table.

This soil is suited to cultivated crops, and in most areas it is cultivated. It is subject to runoff from the adjacent uplands. Diversion terraces can be used to protect the soil from runoff and prevent the resulting rills and gullies. If this soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by a combination of conservation tillage, contour farming, terraces, crop rotation, or other conservation practices.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

585B—Coland-Spillville complex, 2 to 5 percent slopes. This map unit consists of gently sloping, poorly drained and somewhat poorly drained soils in upland drainageways. These soils are susceptible to flooding. The areas are long and narrow and range from 5 to 20 acres in size. The Coland soil makes up about 50 percent of the complex, and the Spillville soil makes up 40 percent.

The Coland soil is in the center of the drainageways, and the Spillville soil is along each side. Areas of these soils are so narrow that it was not practical to map them separately.

Typically, the surface layer of the Coland soil is black clay loam about 10 inches thick. The subsurface layer is black clay loam about 30 inches thick. The substratum to a depth of 60 inches is black or very dark gray, firm clay loam with mottles.

The surface layer of the Spillville soil is very dark brown loam about 10 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 42 inches thick. The substratum to a depth of 60 inches is very dark grayish brown and dark brown loam.

Permeability is moderate, and surface runoff is slow. The available water capacity is high. The surface layer of the Coland soil is 6 to 8 percent organic matter. The surface layer of the Spillville soil is 4 to 5 percent organic matter. The surface layer of both soils has good tilth. The subsoil is low in available phosphorus and very low in available potassium. These soils have a seasonal high water table.

In most areas these soils are in pasture or grassed waterways. The soils are subject to runoff from the adjacent uplands and carry this runoff to the major

streams. Tile drains are used in these soils. Shaping and seeding the center of the channel helps prevent gullying and permits crossing with tillage implements.

If the soils are used as pasture, grazing when the soil is wet causes surface compaction and reduces infiltration. Restricting use during wet periods helps keep the pasture and soil in good condition.

These soils are in capability subclass IIw.

636—Buckney fine sandy loam, 1 to 3 percent slopes. This is a very gently sloping, excessively drained soil on slightly raised areas on bottom lands of the major river valleys. It is subject to flooding. The areas are elongated and irregular in shape and range from 10 to 40 acres in size.

Typically, the surface layer is very dark brown and very dark grayish brown fine sandy loam about 12 inches thick. The subsurface layer is very dark grayish brown and dark brown fine sandy loam about 5 inches thick. The substratum to a depth of 60 inches is brown and very dark grayish brown loamy sand, fine sandy loam, and sandy loam. This soil is calcareous throughout.

Included with this soil in mapping are a few small areas of Hanlon soils that are noncalcareous. They are in level areas and make up 5 to 10 percent of the map unit.

Permeability is moderately rapid, and surface runoff is very slow. The available water capacity is moderate. The surface layer is 3 to 4 percent organic matter and has good tilth. The subsoil is low in available phosphorus and medium in available potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. If this soil is used for cultivated crops, conservation tillage helps prevent excessive soil loss from soil blowing and conserves moisture. The soil is somewhat droughty during periods of low rainfall. In some areas diversions help protect the soil from overflow and siltation from higher elevations.

If this soil is used as pasture, overgrazing causes surface compaction and reduces infiltration. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

Where this soil is within the flood pool of Saylorville Lake it may be subject to flooding of long duration.

This soil is in capability subclass IIIs.

639D—Storden-Salida complex, 9 to 14 percent slopes. This map unit consists of strongly sloping, well drained and excessively drained soils on upland knolls and side slopes. The areas are irregular in shape and range from 5 to 20 acres in size. About 60 to 70 percent of the unit is Storden loam, and 20 to 30 percent is Salida gravelly sandy loam.

The Storden soil is generally on the lower side slopes. The Salida soil is on the crest and shoulder slopes. Areas of the two soils are so intricately mixed or so small in size that it was not practical to map them separately.

Typically, the surface layer of the Storden soil is mixed with the substratum. It is brown and dark grayish brown, calcareous loam about 7 inches thick. The substratum is yellowish brown, calcareous loam to a depth of 60 inches. In a few areas the surface layer is dark brown.

Typically, the surface layer of the Salida soil is mixed with the subsoil. It is dark brown gravelly sandy loam about 5 inches thick. The subsoil is brown gravelly loamy sand about 5 inches thick. The substratum is yellowish brown and pale brown gravelly loamy sand to a depth of 60 inches. In some areas this soil is gravelly loamy sand throughout.

Included in mapping are a few areas of Zenor soils, which have more sand and gravel than the Storden soil and more silt and clay than the Salida soil. The Zenor soils are upslope from the Storden and Salida soils and make up about 10 percent of the map unit.

Permeability of the Storden soil is moderate, and surface runoff is rapid. The surface layer is 1 to 2 percent organic matter and has fair tilth. The substratum is very low in available phosphorus and potassium.

Permeability of the Salida soil is very rapid, and surface runoff is slow. The available water capacity is very low. The surface layer is 1 to 2 percent organic matter and has fair tilth. The subsoil is very low in available phosphorus and potassium.

In most areas these soils are cultivated. Water erosion and soil blowing are hazards where the soils are cultivated. Soil loss can be reduced significantly by conservation tillage, contour farming, crop rotation, or a combination of these practices. Conservation tillage and crop residue left on the surface reduce soil blowing. Returning crop residue to the soil or regularly adding other organic matter helps improve fertility and tilth and conserves moisture. The Salida soil is very droughty, and crop yields on that soil are low in most years.

If the soils are used as pasture, overgrazing causes increased runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and the soils in good condition.

These soils are in capability subclass IVe.

639E—Storden-Salida complex, 14 to 25 percent slopes. This map unit consists of moderately steep and steep, well drained and excessively drained soils on upland knolls and side slopes. The areas are irregular in shape and range from 10 to 20 acres in size. About 60 to 70 percent of the unit is Storden loam, and 20 to 30 percent is Salida gravelly sandy loam.

The Storden soil is on the lower side slopes. The Salida soil is on the crest and shoulder slopes. Areas of the two soils are so intricately mixed or so small in size that it was not practical to map them separately.

Typically, the surface layer of the Storden soil is dark grayish brown, calcareous loam about 4 inches thick. The substratum is yellowish brown, calcareous loam to a depth of 60 inches.

Typically, the surface layer of the Salida soil is very dark grayish brown and dark brown sandy loam about 6

inches thick. The substratum is yellowish brown gravelly coarse sand to a depth of about 60 inches.

Included with this map unit are a few areas of Zenor soils that have more sand and gravel than the Storden soil and more silt and clay than the Salida soil. The Zenor soils are upslope from the Storden and Salida soils and make up about 10 percent of the map unit.

Permeability of the Storden soil is moderate, and surface runoff is rapid. The available water capacity of the Storden soil is high. Permeability of the Salida soil is very rapid, and surface runoff is slow. The available water capacity of the Salida soil is very low. The surface layer of both soils is 1 to 2 percent organic matter and has fair tilth. The substratum of both soils is very low in available phosphorus and potassium.

In most areas these soils are in pasture. The Storden soil is suited to grasses and legumes for hay and pasture. The Salida soil is suited to pasture. The soils in this unit have very severe limitations to use as cropland because of the hazards of erosion and soil blowing, and droughtiness on the Salida soil. Soil loss can be reduced significantly by a combination of crop rotation, contour farming, conservation tillage, terraces, or other conservation practices. Conservation tillage and crop residue left on the surface reduce the hazard of soil blowing. Returning crop residue or regularly adding other organic matter helps improve fertility and tilth and increases water holding capacity and water infiltration.

If these soils are used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

These soils are in capability subclass VIe.

655—Crippin loam, 1 to 3 percent slopes. This is a very gently sloping, somewhat poorly drained soil on low convex upland rises. Slopes are typically short. The areas are irregular in shape and range from 5 to 10 acres in size.

Typically, the surface layer is black, calcareous loam about 8 inches thick. The subsurface layer is very dark grayish brown, calcareous loam about 10 inches thick. The subsoil is about 12 inches thick. In the upper part it is dark grayish brown, calcareous loam, and in the lower part it is grayish brown, calcareous loam. The substratum to a depth of 60 inches is grayish brown, mottled, calcareous loam.

Included with this soil in mapping are a few small areas of Nicollet soils that are deeper to carbonates. The included soils are in similar landscape positions and make up about 5 percent of the map unit.

Permeability is moderate, and surface runoff is slow. The available water capacity is high. The surface layer is 4 to 6 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and potassium. This soil has a seasonal high water table.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, erosion is a very slight hazard on the more sloping areas. Conservation tillage helps prevent excessive soil loss from soil blowing. Returning crop residue helps maintain good tilth.

If this soil is used as pasture, overgrazing causes surface compaction and reduces infiltration. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is in capability class I.

733—Calco silty clay loam, 0 to 2 percent slopes. This is a nearly level, poorly drained soil on first bottoms and low benches. It is subject to flooding. The areas are long and narrow and range from 10 to 30 acres in size.

Typically, the surface layer is black, calcareous silty clay loam about 12 inches thick. The subsurface layer is black, calcareous clay loam about 21 inches thick. The subsoil is about 12 inches thick and is very dark gray and dark gray, mottled, calcareous clay loam. The substratum to a depth of about 60 inches is olive gray and gray, mottled, calcareous clay loam.

Permeability is moderate, and surface runoff is slow. The available water capacity is high. The surface layer is 6 to 8 percent organic matter and has good tilth. The subsoil is medium in available phosphorus and very low in available potassium. This soil has a seasonal high water table.

If drained, this soil is suited to cultivated crops, and in most areas it is cultivated. Tile drainage works well in this soil if suitable outlets are available. This soil warms slowly in spring and tends to dry out cloddy and hard if worked when wet. It dries out slowly in spring because of a high water table. In low-lying areas and old bayous the soil tends to pond after floods. Streambank cutting occurs in places. The high content of lime restricts the availability of phosphorus, potassium, and other micronutrients.

This soil is in capability subclass IIw.

778—Sattre loam, 0 to 2 percent slopes. This is a nearly level, well drained soil on stream benches. The areas are irregular in shape and range from 10 to 20 acres in size.

Typically, the surface layer is very dark grayish brown loam about 9 inches thick. The subsurface layer is brown loam about 6 inches thick. The subsoil is about 28 inches thick. In the upper part it is brown loam, and in the lower part it is dark yellowish brown loamy sand. The substratum is yellowish brown sand to a depth of 60 inches.

Included with this soil in mapping are a few small areas of somewhat poorly drained soils in swales. The included soils make up 2 to 5 percent of the map unit.

Permeability of this soil is moderate in the upper part and very rapid in the lower part. Surface runoff is slow. The available water capacity is moderate. The surface layer is generally acid unless lime has been added. It is 2 to 4 percent organic matter and has good tilth. The

subsoil is very low in available phosphorus and low in available potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. Generally, the available water is adequate for crops. In periods of low rainfall, however, the soil is droughty because of the underlying sand and gravel.

This soil is in capability class I.

778B—Sattre loam, 2 to 5 percent slopes. This is a gently sloping, well drained soil on stream benches. The areas are irregular in shape and are 10 to 20 acres in size.

Typically, the surface layer is mixed with the subsurface layer. It is very dark gray loam about 8 inches thick. The subsoil is about 30 inches thick. It is brown and dark yellowish brown gravelly clay loam. The substratum to a depth of 60 inches is yellowish brown sand and gravel. In some uncultivated areas there is a subsurface layer about 1 inch thick.

Permeability is moderate in the upper part and very rapid in the lower part. Surface runoff is slow. The available water capacity is moderate. The surface layer is generally acid unless lime has been added. It is 2 to 4 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and low in available potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices. Because of the underlying sand and gravel, cuts for terracing should be held to a minimum to avoid excessive reduction of the available water capacity. These soils are droughty when rainfall is below normal or during extended dry periods.

This soil is in capability subclass IIe.

778C—Sattre loam, 5 to 9 percent slopes. This is a moderately sloping, well drained soil on stream benches. The areas are irregular in shape and range from 2 to 10 acres in size.

Typically, the surface layer is mixed with the subsurface layer. It is dark brown and brown loam about 9 inches thick. The subsoil is dark yellowish brown loam about 27 inches thick. The substratum to a depth of 60 inches is dark yellowish brown loamy sand and sand. In some uncultivated areas there is a subsurface layer about 1 inch thick.

Permeability is moderate in the upper part and very rapid in the lower part. Surface runoff is slow. The available water capacity is moderate. The surface layer is generally acid unless lime has been added. It is 2 to 4 percent organic matter and has good tilth. The subsoil is very low in available phosphorus and low in available potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, erosion is a hazard. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices. This soil is droughty in years of below normal rainfall or during extended dry periods.

If this soil is used as pasture, overgrazing causes surface compaction and increased runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

823—Ridgeport sandy loam, 0 to 2 percent slopes. This is a nearly level, somewhat excessively drained soil on bottom lands and stream terraces. The areas are irregular in shape and range from 5 to 15 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown sandy loam about 6 inches thick. The subsoil is 23 inches thick. It is dark yellowish brown and brown sandy loam and loamy sand. The substratum to a depth of 60 inches is dark yellowish brown and light brownish gray, calcareous sand. In some areas the soil is shallower to sand and gravel.

Permeability is moderately rapid in the upper part and rapid in the lower part. Surface runoff is slow. The available water capacity is low. The surface layer is generally acid unless lime has been added. It is 2 to 4 percent organic matter and has fair tilth. The subsoil is low in available phosphorus and very low in available phosphorus and very low in available potassium.

In most areas this soil is cultivated. If the soil is used for cultivated crops, conservation tillage helps prevent excessive soil loss from soil blowing. This soil is droughty in most years.

This soil is in capability subclass IIIs.

823B—Ridgeport sandy loam, 2 to 5 percent slopes. This is a gently sloping, somewhat excessively drained soil on bottom lands and stream terraces. Slopes are typically short. The areas are irregular in shape and range from 10 to 20 acres in size.

Typically, the surface layer is very dark brown and dark brown sandy loam about 9 inches thick. The subsoil is dark yellowish brown coarse sandy loam 21 inches thick. The substratum to a depth of 60 inches is yellowish brown coarse loamy sand that grades, with depth, to variegated, calcareous sand. In some areas the soil is shallower to the underlying coarse material.

Permeability is moderately rapid in the upper part and rapid in the lower part. Surface runoff is slow. The available water capacity is low. The surface layer is generally acid unless lime has been added. It is 2 to 4 percent organic matter and has fair tilth. The subsoil is low in available phosphorus and very low in available potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, soil blowing and water erosion are hazards. Soil

loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices. Soil blowing can be reduced by conservation tillage or by leaving crop residue on the surface. Because of the underlying sand and gravel, cuts for terracing should be kept to a minimum to avoid excessive reduction of the available water capacity. Returning crop residue to the soil or regularly adding other organic matter helps improve fertility and tilth and conserve moisture. This soil is droughty in most years.

This soil is in capability subclass IIIe.

823C2—Ridgeport sandy loam, 5 to 9 percent slopes, moderately eroded. This is a moderately sloping, somewhat excessively drained soil on bottom lands and stream terraces. Slopes are typically short. The areas are irregular in shape and range from 10 to 20 acres in size.

Typically, the surface layer is mixed dark brown and brown sandy loam about 7 inches thick. The subsoil is 23 inches thick. In the upper part it is brown and dark yellowish brown sandy loam, and in the lower part it is dark yellowish brown coarse sand. The substratum to a depth of 60 inches is variegated, calcareous sand and gravel.

Permeability is moderately rapid in the upper part and rapid in the lower part. Surface runoff is slow. The available water capacity is low. The surface layer is generally acid unless lime has been added. It is 1 to 2 percent organic matter and has fair tilth. The subsoil is low in available phosphorus and very low in available potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. If the soil is used for cultivated crops, soil blowing and water erosion are hazards. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices. Soil blowing can be reduced by conservation tillage or by leaving crop residue on the surface. Because of the underlying sand and gravel, cuts for terracing should be held to a minimum to avoid excessive reduction of the available water capacity. Returning crop residue to the soil or regularly adding other organic matter helps improve fertility and tilth and conserve moisture. This soil is droughty in most years.

This soil is in capability subclass IIIe.

828B—Zenor sandy loam, 2 to 5 percent slopes. This is a gently sloping, somewhat excessively drained soil on knolls and side slopes of upland glacial outwash areas. The areas are irregular in shape and range from 2 to 20 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is dark brown sandy loam about 5 inches thick. The subsoil is about 20 inches thick. In the upper part it is brown loam, and in the lower part it is dark yellowish brown loam. The substratum to a depth of about 60 inches is yellowish brown fine sandy loam. The gravel content ranges from 5 to 15 percent throughout.

Included with this soil in mapping are a few small areas of Storden soils that are calcareous within 10 inches of the surface. The Storden soils have more clay throughout and have a higher available water capacity. They are in similar positions on the landscape and make up about 10 percent of the map unit.

Permeability is moderately rapid in the subsoil and rapid in the lower part of the substratum. Surface runoff is slow. The available water capacity is moderate. The surface layer is generally acid unless lime has been added. It is about 2 to 3 percent organic matter and has good tilth. The subsoil is low in available phosphorus and very low in available potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. Water erosion and soil blowing are hazards if the soil is cultivated. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices. Conservation tillage or crop residue left on the surface reduces soil blowing.

If this soil is used as pasture, overgrazing causes surface compaction and decreases infiltration. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

828C—Zenor sandy loam, 5 to 9 percent slopes. This is a moderately sloping, somewhat excessively drained soil on knolls and side slopes of upland glacial outwash areas. The areas are irregular in shape and range from 5 to 25 acres in size.

Typically, the surface layer is very dark brown sandy loam about 8 inches thick. The subsurface layer is dark brown and brown sandy loam about 4 inches thick. The subsoil is about 16 inches thick. In the upper part it is brown and dark yellowish brown loam, and in the lower part it is dark yellowish brown sandy loam. The substratum to a depth of about 60 inches is yellowish brown sandy loam grading with depth to light yellowish brown sand. The gravel content ranges from 5 to 15 percent throughout.

Included with this soil in mapping are a few small areas of Storden soils that are calcareous within 10 inches of the surface. The Storden soils have more clay throughout and have a higher available water capacity. They are in similar positions on the landscape and make up about 10 percent of the map unit.

Permeability is moderately rapid in the subsoil and rapid in the lower part of the substratum.

Surface runoff is medium. The available water capacity is moderate. The surface layer is generally acid unless lime has been added. It is about 2 to 3 percent organic matter and has good tilth. The subsoil is low in available phosphorus and very low in available potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. Water erosion and soil blowing are

hazards if the soil is cultivated. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices. Conservation tillage or crop residue left on the surface reduces soil blowing. The crop residue helps maintain good tilth, conserve moisture, and increase water infiltration. This soil is droughty in years of below normal rainfall or during extended dry periods.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

828C2—Zenor sandy loam, 5 to 9 percent slopes, moderately eroded. This is a moderately sloping, somewhat excessively drained soil on knolls and side slopes of upland glacial outwash areas. The areas are irregular in shape and range from 5 to 25 acres in size.

Typically, the surface layer is mixed dark brown and brown sandy loam about 6 inches thick. The subsoil is about 28 inches thick. In the upper part it is brown sandy loam, and in the lower part it is yellowish brown loamy sand. The substratum to a depth of 60 inches is yellowish brown sand. The gravel content ranges from 5 to 15 percent throughout.

Included with this soil in mapping are a few small areas of Storden soils that are calcareous within 10 inches of the surface. The Storden soils have more clay throughout and have a higher available water capacity. They are in similar positions on the landscape and make up about 15 percent of the map unit.

Permeability is moderately rapid in the subsoil and rapid in the lower part of the substratum. Surface runoff is medium. The available water capacity is moderate. The surface layer is generally acid unless lime has been added. It is 1 to 2 percent organic matter and has fair tilth. The subsoil is low in available phosphorus and very low in available potassium.

This soil is suited to cultivated crops, and in most areas it is cultivated. This soil is moderately eroded. In some places gullying is a hazard. Soil loss can be reduced significantly by conservation tillage, contour farming, terraces, crop rotation, or a combination of these practices. Conservation tillage or crop residue left on the surface reduces soil blowing. Returning the crop residue to the soil helps maintain good tilth, conserve moisture, and increase water infiltration. This soil is droughty in years of below normal rainfall or during extended dry periods.

If this soil is used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

This soil is in capability subclass IIIe.

829D2—Zenor-Storden complex, 9 to 14 percent slopes, moderately eroded. This map unit consists of strongly sloping, somewhat excessively drained and well drained soils on upland knolls and side slopes. Most areas are dissected by shallow flat drainageways. The areas range from 2 to 40 acres in size and are 40 to 50 percent Zenor sandy loam and 35 to 45 percent Storden loam.

The Zenor soil is on side slopes and the broader ridgetops. The Storden soil is on narrow ridgetops and sharp slope breaks. Areas of the two soils are so intricately mixed that it was not practical to map them separately.

Typically, the surface layer of the Zenor soil is brown sandy loam about 6 inches thick. The subsoil is loamy sand about 18 inches thick. It is dark yellowish brown in the upper part and yellowish brown in the lower part. The substratum to a depth of about 60 inches is yellowish brown sandy loam and loamy sand. The gravel content ranges from 5 to 15 percent throughout.

Typically, the surface layer of the Storden soil is mixed with the substratum. It is brown, calcareous loam about 6 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam. In a few uncultivated areas the surface layer is very dark grayish brown and is about 5 inches thick.

Permeability of the Zenor soil is moderately rapid in the upper part and rapid in the lower part. Surface runoff is slow. The available water capacity is moderate. The surface layer is acid unless lime has been added. It is 1 to 2 percent organic matter.

Permeability of the Storden soil is moderate. Surface runoff is rapid. The available water capacity is high. The surface layer is less than 1 percent organic matter.

In many areas these soils are cultivated. In some areas they are in pasture. If the soils are used for cultivated crops, water erosion and soil blowing are very severe hazards. Soil loss can be reduced significantly by a combination of crop rotation, contour farming, conservation tillage, or other conservation practices. Returning crop residue to the soil or regularly adding other organic matter helps improve fertility and tilth and increase water infiltration. Zenor soils are droughty in years of below normal rainfall or during extended dry periods.

If these soils are used as pasture, overgrazing causes surface compaction and increases runoff. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

These soils are in capability subclass IVe.

829E2—Zenor-Storden complex, 14 to 25 percent slopes, moderately eroded. This map unit consists of moderately steep and steep, somewhat excessively drained and well drained soils on upland knolls and side slopes. Most areas are dissected by shallow flat drainageways. The areas range from 2 to 20 acres in size. The unit is 40 to 50 percent Zenor sandy loam and 35 to 45 percent Storden loam.

The Zenor soil is on side slopes and the broader areas between knolls. The Storden soil is on narrow

ridgetops, on the top of knolls, and on sharp slope breaks. Areas of the two soils are so intricately mixed that it was not practical to map them separately.

Typically, the Zenor soil has a surface layer that is dark brown sandy loam about 6 inches thick. The subsoil is dark yellowish brown sandy loam about 11 inches thick. The substratum to a depth of about 60 inches is yellowish brown loamy sand. The gravel content ranges from 5 to 15 percent throughout.

Typically, the surface layer of the Storden soil is brown, calcareous loam about 6 inches thick. The substratum to a depth of 60 inches is calcareous loam. The upper part is dark yellowish brown, and the lower part is yellowish brown.

Permeability of the Zenor soil is moderately rapid in the upper part and rapid in the lower part. Surface runoff is slow. The available water capacity is moderate. The surface layer is generally acid unless lime has been added. It is 1 to 2 percent organic matter and has fair tilth. The subsoil is low in available phosphorus and very low in available potassium.

Permeability of the Storden soil is moderate. Surface runoff is rapid. The available water capacity is high. The surface layer is less than 1 percent organic matter and has fair tilth.

In most areas these soils were once cultivated but are now in pasture. These soils are best suited to permanent pasture. Because of slope, low productivity, and the severe hazard of erosion, the soils are poorly suited to cultivated crops. Soil loss can be reduced significantly if a good vegetative cover is maintained.

If these soils are used as pasture, overgrazing causes surface compaction, and, thus, infiltration is decreased. Proper stocking rates and pasture rotation help keep the pasture and soil in good condition.

These soils are in capability subclass VIe.

1135—Coland clay loam, channeled, 0 to 2 percent slopes. This is a nearly level, poorly drained soil on first bottoms and low benches that are subject to flooding. The areas, which are dissected by meandering streams and oxbows, are long and narrow and range from 10 to 60 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is 27 inches thick. It is black, firm clay loam grading to loam and has strong brown mottles in the lower part. The substratum is very dark gray, mottled clay loam to a depth of 60 inches. In some areas there is sandy loam below a depth of 40 inches.

Permeability is moderate, and surface runoff is slow. The available water capacity is high. The surface layer is 6 to 7 percent organic matter. It has good tilth. The subsoil is low in available phosphorus and very low in available potassium. This soil has a seasonal high water table.

This soil is best suited to use as pasture, and in most areas it is in pasture. Pastures can be improved by introducing grasses and legumes that tolerate flooding and by removing brush.

If this soil is used as pasture, grazing when the soil is wet causes surface compaction and infiltration decreases. Restricting use during wet periods helps keep the pasture and soil in good condition.

This soil is in capability subclass Vw.

1636—Buckney fine sandy loam, channeled, 0 to 2 percent slopes. This is a nearly level, excessively drained soil on slightly raised areas on flood plains along major streams and rivers. It is subject to flooding. The areas, which are dissected by meandering streams and oxbows, are elongated and range from 40 to 100 acres in size.

Typically, the surface layer is very dark grayish brown fine sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown fine sandy loam about 8 inches thick. The substratum to a depth of 60 inches is brown fine sandy loam. This soil is calcareous throughout. In some areas the soil is overlain by recently deposited, stratified alluvial sediment that has more sand.

Included with this soil in mapping are small areas of Coland, Hanlon, and Spillville soils. These soils do not have free carbonates above a depth of 20 inches and are wetter. Their surface and subsurface layers combined are more than 24 inches thick. The Coland and Spillville soils have more clay throughout. The included soils are on first bottom lands and make up about 20 percent of the map unit.

Permeability is moderately rapid, and surface runoff is very slow. The available water capacity is moderate. The surface layer is 3 to 4 percent organic matter. The subsoil is low in available phosphorus and medium in available potassium.

In most areas this soil is used as woodland. Most areas of this soil are within the flood pool of Saylorville Lake and are subject to occasional flooding of long duration.

This soil is in capability subclass VIw.

2485B—Spillville-Buckney complex, 2 to 5 percent slopes. This map unit consists of gently sloping, somewhat poorly drained and excessively drained soils on flood plains of the narrow, meandering tributaries of the major rivers and streams (fig. 9). These soils are subject to flooding. The areas are long and narrow and range from 40 to 100 acres in size. Areas of the Spillville and Buckney soils are so intricately mixed or so small in size that it was not practical to map them separately.

Typically, the surface layer of the Spillville soil is very dark brown loam about 10 inches thick. The subsurface layer is very dark brown and very dark grayish brown loam about 30 inches thick. The substratum to a depth of 60 inches is very dark grayish brown and dark brown loam. In some areas the substratum is heavy sandy loam.

Figure 9.—Typical area of Spillville-Buckney complex, 2 to 5 percent slopes, on narrow flood plains of meandering streams.

Typically, the surface layer of the Buckney soil is very dark brown fine sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown fine sandy loam about 10 inches thick. The substratum to a depth of 60 inches is brown and very dark grayish brown loamy sand and sandy loam. This soil is calcareous throughout.

Permeability of the Spillville soil is moderate. Surface runoff is very slow or slow. The available water capacity is high. The surface layer is 4 to 5 percent organic matter and has good tilth. The subsoil is low in available phosphorus and very low in available potassium. The Spillville soil has a seasonal high water table.

Permeability of the Buckney soil is moderately rapid. Surface runoff is very slow or slow. The available water capacity is moderate. The surface layer has good tilth. The subsoil is low in available phosphorus and medium in available potassium.

In most areas these soils are in pasture or brush. It is not practical to cultivate these soils because the meander belt of the streams dissects the narrow valley where the soils are located. Consequently, the areas are small and inaccessible. If these soils are used as pasture, grazing when the soil is wet causes surface compaction, which, in turn, decreases infiltration. Restricting use during wet periods helps keep the pasture in good condition.

These soils are suited to use as habitat for woodland wildlife. Under natural conditions adequate food and cover are available. In areas that have been cleared for agriculture, food and cover for wildlife can be reestablished. These soils are adjacent to steep, wooded side slopes that provide additional food and cover for woodland wildlife.

These soils are in capability subclass VIw.

4055—Nicollet-Urban land complex, 1 to 3 percent slopes. This map unit consists of the very gently sloping, somewhat poorly drained Nicollet soil and Urban land. The Nicollet soil makes up 35 to 45 percent of the map unit, and Urban land makes up 30 to 40 percent. The areas of this complex are irregular in shape and range from 50 to 150 acres in size. They include the cities of

Boone, Madrid, and Ogden, where detailed identification of the soils was not feasible because the soils have been altered or covered by structures.

The Nicollet soil is on toe slopes on slightly convex or plane, sloping ground moraines where the relief is low. Typically, the surface layer of the Nicollet soil is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 9 inches thick. The subsoil is dark grayish brown, mottled loam about 20 inches thick. The substratum is grayish brown and olive gray, mottled loam to a depth of 60 inches. In some areas the subsoil is dark brown.

In areas of Urban land the soils have been altered or are covered by streets, parking lots, and buildings and other structures.

Included in mapping this complex are areas of Webster and Canisteo soils. Webster soils are wetter than Nicollet soils. Canisteo soils also are wetter, and they are calcareous. Also included are some areas of well drained Clarion soils and soils, in a few small depressions, that have more clay in the subsoil than Nicollet soils and that tend to become ponded. The included soils make up 20 to 30 percent of the map unit.

Permeability of the Nicollet soil is moderate, and surface runoff is slow. The available water capacity is high. This soil has a seasonal high water table. It is well suited to landscaping and is used mainly for lawns, gardens, parks, and playgrounds.

This unit is not assigned to a capability subclass.

4138B—Clarion-Urban land complex, 2 to 5 percent slopes. This map unit consists of gently sloping, well drained Clarion soil and Urban land. The Clarion soil makes up 35 to 45 percent of the map unit, and Urban land makes up 30 to 40 percent. The areas of this complex are irregular in shape and range from 50 to 150 acres in size. Most of the areas are within the cities of Boone, Madrid, and Ogden, where detailed identification of the soils was not feasible because the soils have been altered or covered by structures.

The Clarion soil is on convex knolls on uplands. The slopes are mainly short. Typically, the surface layer of the Clarion soil is black loam about 8 inches thick. The subsurface layer is very dark grayish brown loam about 4 inches thick. The subsoil is about 28 inches thick. It is brown loam grading to yellowish brown with depth. The substratum to a depth of about 60 inches is light yellowish brown and strong brown, calcareous loam. In some areas carbonates are within 20 inches of the surface.

In areas of Urban land the soils have been altered or are covered by streets, parking lots, buildings, and other structures.

Permeability of the Clarion soil is moderate, and surface runoff is medium. The available water capacity is high. The soil is well suited to landscaping and is used mainly for lawns, gardens, parks, and playgrounds.

This unit is not assigned to a capability subclass.

4138C—Clarion-Urban land complex, 5 to 9 percent slopes. This map unit consists of moderately sloping, well drained Clarion soil and Urban land. The Clarion soil makes up 35 to 45 percent of the map unit, and Urban land makes up 30 to 40 percent. The areas of this complex are irregular in shape and range from 10 to 30 acres in size. Most of the areas are within the cities of Boone, Madrid, and Ogden, where detailed identification of the soils was not feasible because the soils have been altered or covered by structures.

The Clarion soil is on knolls and convex side slopes. The slopes are mainly short. Typically, the surface layer of the Clarion soil is very dark brown and very dark grayish brown loam about 10 inches thick. The subsoil is brown loam about 22 inches thick. The substratum to a depth of 60 inches is yellowish brown, calcareous loam. In some areas carbonates are directly below the surface layer. In some areas the substratum is sandy loam.

In areas of Urban land the soils have been altered or are covered by streets. parking lots, buildings, and other structures.

Included in mapping, and making up 20 to 30 percent of the map unit, are small areas of Storden soils that are calcareous throughout.

Permeability of the Clarion soil is moderate, and surface runoff is medium. The available water capacity is high. This soil is used mainly for lawns, gardens, parks, and playgrounds.

This unit is not assigned to a capability subclass.

4507—Canisteo-Urban land complex, 0 to 2 percent slopes. This map unit consists of nearly level, poorly drained Canisteo soil and Urban land. The Canisteo soil makes up 35 to 45 percent of the map unit, and Urban land makes up 30 to 40 percent. The areas of this complex are irregular in shape and generally are more than 40 acres in size. Most of the areas are within the cities of Boone, Madrid, and Ogden, where detailed identification of the soils was not feasible because the soils have been altered or covered by structures.

The Canisteo soil is in swales on uplands. Typically, the surface layer of the Canisteo soil is black, calcareous silty clay loam about 8 inches thick. The subsurface layer is very dark gray, calcareous silty clay loam about 10 inches thick. The subsoil is about 18 inches thick. In the upper part it is dark gray and olive gray, mottled, calcareous silty clay loam, and in the lower part it is pale olive, calcareous clay loam that has strong brown mottles. The substratum to a depth of 60 inches is light olive gray, mottled, calcareous clay loam. In some areas the soil does not have lime in the upper 10 inches.

In areas of Urban land the soils have been altered or are covered by streets, parking lots, buildings, and other structures.

Included in mapping, and making up 20 to 30 percent of the map unit, are areas of Okoboji and Webster soils. Okoboji soils tend to become ponded, and Webster soils do not have free carbonates.

Permeability of the Canisteo soil is moderate, and surface runoff is slow to ponded. This soil has a seasonal high water table. The surface layer is easily landscaped if the moisture content is suitable. This soil is used mainly for lawns, gardens, parks, and playgrounds.

This unit is not assigned to a capability subclass.

5010—Pits, gravel. This map unit consists of both active and inactive gravel pits. Most active pits are adjacent to areas that were once a source of gravel.

Typically, gravel pits contain gravelly coarse and fine sand and are 5 to 15 percent silt and clay.

Most of the pits that are no longer a source of sand and gravel are barren or support drought-resistant shrubs, forbs, and grasses. Some of the smaller, abandoned pits have been filled with material from adjacent areas and are managed with the adjacent soils.

Gravel pits that are no longer active have good potential for use as wildlife habitat and for recreation. Many of these areas have ponds. To improve the potential for recreation, the pits should be shaped to eliminate hazardous areas. Special care is required for the establishment of adapted plants because the soil material is droughty.

Gravel pits have poor potential for building site development and onsite sewage disposal. It is very difficult to improve the potential for onsite sewage disposal because of the very rapid permeability and the hazard of ground water contamination. Septic tank disposal fields can be installed if onsite investigations indicate that ground water contamination is not a hazard.

This unit is not assigned to a capability subclass.

5020—Dumps, mine. This map unit consists of large, very steep piles of acid shale or remnants of such piles. Runoff from these dumps is acid and has an adverse affect on adjacent soils. Diversions are needed to protect the adjacent soils.

Many of the mine dumps are a source of shale. The shale is used by the county as fill material on gravel roads.

Mine dumps from which most of the shale has been removed are barren or have very sparse vegetation.

This unit is not assigned to a capability subclass.

5040—Orthents, loamy. This map unit consists of areas from which soil material has been removed. The areas are adjacent to or are in the vicinity of county roads, highways, or railroads.

Typically, the soil material is calcareous loam. The surface layer and subsoil of the original soil have been removed in most places. In some areas the surface layer has been replaced, and it is 12 to 24 inches thick.

Permeability is reduced by soil compaction, which is caused by the heavy equipment used to remove soil material. Runoff is medium. Reaction is mildly alkaline if the substratum is exposed. If the surface soil has been replaced, reaction ranges from slightly acid to mildly alkaline. The content of organic matter varies with the condition of the surface. The available water capacity is also variable, depending on the material remaining in place. The subsoil is low to very low in available phosphorus and potassium. In borrow areas where the surface soil has not been replaced, the soil becomes hard when dry and is difficult to till.

In most of these areas the soil can be cultivated. Growing deep-rooted legumes, returning or adding organic matter to the soil, and deep chiseling help open the compacted zone, improve soil tilth, and increase yields.

This unit is not assigned to a capability subclass.

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

General management needed for crops and pasture is suggested in this section. The system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

In 1974 in Boone County, more than 308,000 acres was used for crops and pasture, according to the 1974 Iowa Agriculture Statistics (*24*). Of this total, about 26,000 acres was used for permanent pasture; 260,000 acres for row crops, mainly corn and soybeans; 18,000 acres for close grown crops, mainly oats; and 9,000 acres for hay. The rest was idle cropland.

The potential of the soils in Boone County for increased production of food is good. About 14,000 acres of potentially good cropland is currently used as woodland and about 27,000 acres as pasture, according to the Conservation Needs Inventory of 1967 (*22*). In addition to the reserve productive capacity represented by this land, food production could also be increased considerably by extending the latest crop production technology to all cropland in the county.

Acreage in crops and pasture has gradually been decreasing as more and more land is used for urban development. It was estimated that in 1967 there were about 15,000 acres of urban and built-up land in the county. That acreage has been growing at the rate of about 400 acres per year. The use of this soil survey to help make land use decisions regarding the future role of farming in the county is discussed in the section "General soil map units."

Soil erosion by water and wind is the major soil problem on about 90 percent of the cropland and pasture in Boone County (fig. 10). Water erosion is a hazard where slopes are more than 2 percent. Clarion, Hayden, Lester, and Wadena soils, for example, have slopes of more than 2 percent.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, Jacwin soils, for example. Erosion also reduces productivity on soils that tend to be droughty, Salida gravelly sandy loam and Zenor soils, for example. Second, soil erosion on farmland results in sedimentation of streams. Control of erosion minimizes pollution of streams by sediment and improves the quality of water for municipal use, for recreation, and for fish and wildlife.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps vegetative cover on the soil for

Figure 10.—This area of Clarion loam, 5 to 9 percent slopes, shows erosion from water. Sediment has been deposited along the fence row.

extended periods can hold soil loss by erosion to an amount that will not reduce the productive capacity of the soils. On livestock farms, which require pasture and hay, the legume and grass forage crops in the cropping system reduce erosion on sloping land and also provide nitrogen and improve soil tilth for the following crops. Good grazing management is especially important on steep soils, Hayden-Storden soils, for example, to prevent soil compaction and the formation of gullies (fig. 11).

In most areas of the gently sloping Clarion, Hayden, and Lester soils, slopes are so short and irregular that contour tillage or terracing is not practical. On these soils, a cropping system that provides substantial vegetative cover is required to control erosion, unless minimum tillage is practiced. Minimizing tillage and

leaving crop residue on the surface help to increase infiltration and reduce the hazards of runoff and erosion. These practices can be adapted to all soils in Boone County. No-tillage for corn and soybeans, which is becoming common on an increasing acreage, is effective in reducing erosion on sloping soils and can be adapted to most of the soils.

Terraces and diversions reduce the length of the slope and reduce runoff and erosion. They are most practical on deep, well drained soils that have regular slopes. In most areas, Clarion, Hayden, and Storden soils are suited to terraces and diversions.

Contouring and, in some places, contour stripcropping are also used to control erosion in Boone County. Soils that have smooth, uniform slopes, including, in some areas, the sloping Clarion, Hayden, Lester, and Storden soils, are best suited to these practices.

Soil blowing is a hazard of most of the unprotected soils. The damage is most severe following a crop of soybeans. Soil blowing can damage soils in a few hours if winds are strong and the soils are dry and bare of vegetation or surface mulch. Maintaining vegetative cover, surface mulch, or a rough surface through proper tillage minimizes soil blowing. Windbreaks of adapted shrubs and trees, such as Tatarian honeysuckle and eastern white pine, are effective in reducing soil blowing. The expected height of specified trees at 20 years of age is shown in table 7.

Information on the design of erosion control practices for each kind of soil is available at the local office of the Soil Conservation Service.

Soil drainage is a management need on about 40 percent of the acreage used for crops and pasture in Boone County. Some soils are so wet in their natural state that the production of crops common to the area is generally not possible. These soils are the very poorly drained Ames, Blue Earth, Okoboji, and Palms soils,

Figure 11.—Good grazing management can help prevent the formation of gullies.

which make up about 10,400 acres. However, in many areas these soils have been artificially drained and are presently being cropped.

Unless artificially drained, the poorly drained soils are so wet that crops are damaged in most years. These soils are the Biscay, Calco, Canisteo, Coland, Dundas, Harcot, Harps, Marna, Talcot, and Webster soils, which make up about 139,400 acres.

Most of the somewhat poorly drained soils, Guckeen, Le Sueur, Luther, and Nicollet soils, for example, do not need artificial drainage.

Intensive row cropping on very poorly drained soils generally requires a combination of tile drainage and tile intakes and, in some places, surface drainage. Tile drainage is generally adequate on poorly drained soils. Drains need to be more closely spaced in soils that have slow permeability than in the more permeable soils. Tile drainage is very slow in Ames, Marna, and Okoboji soils. Finding adequate outlets for a tile drainage system is difficult in many areas of Ames, Blue Earth, Okoboji, and Palms soils.

Information on drainage design for each kind of soil is available at the local office of the Soil Conservation Service.

Soil fertility is low for most of the soils in Boone County. Most of the prairie soils, Canisteo, Clarion, Nicollet, and Webster soils, for example, are very low in phosphorus and potash. The forested soils, Hayden and Luther soils, for example, are medium in available phosphorus and very low to low in available potash.

The level of nitrogen available to plants is related to the content of organic matter. The prairie soils are typically medium to high in content of organic matter. Poor and very poorly drained soils, Blue Earth, Calco, Canisteo, Coland, Okoboji, Palms, and Webster soils, for example, are high or very high in organic matter. The forested soils are typically low in organic matter.

Soils in the survey area typically range from strongly acid to moderately alkaline. The mildly to moderately alkaline soils, Blue Earth, Canisteo, Crippin, Harcot, Harps, Storden, and Talcot soils, for example, have free carbonates in the surface layer. High pH or alkaline conditions reduce the levels of available phosphorus and micronutrients. The forested soils have a lower pH and may require lime. On all soils, additions of lime and fertilizer should be based on the results of soil tests, on the need of the crop, and on the expected yields.

The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to apply. The use and rate of application of herbicides are also affected by the content of organic matter, pH level, carbonates, and soil texture.

Soil tilth is an important factor in the germination and emergence of seeds and in the infiltration of water into the soil. Soils that are granular and porous have good tilth. Most of the soils in Boone County have good tilth. Management practices that maintain or increase the level of organic matter also improve soil tilth and soil structure.

The forest soils, Hayden, Luther, Dundas, and Ames soils, have poorer tilth than the prairie soils. Returning crop residue, manure, and other organic material to the soil is especially important in improving soil structure and in preventing crust formation. Crust formation reduces infiltration and increases runoff and erosion. If these soils are wet when plowed, they tend to be cloddy when dry, making a good seedbed difficult to prepare.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit (*20*). Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is shown in table 6. The capability classification of each map unit is given in the section "Detailed soil map units."

windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and tall-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

According to the Boone County Outdoor Recreation Plan, about 6,600 acres of land is being used for recreation in the county. An additional 6,600 acres is held by the U.S. Army Corps of Engineers as part of the Saylorville Reservoir project. The Corps has provided several boat slips in the area. Private recreation facilities, mostly church and youth organization camps, take up almost 4,000 acres. State facilities take up about 1,600 acres. The largest state recreation area in the county is Ledges State Park. Boone County has developed the 600-acre Don Williams Park. Municipal parks total nearly 400 acres. McHose Park, in the city of Boone, makes up most of this acreage. Most of the public and private recreation areas in Boone County are along the Des Moines River. Much of the forested land along the river has good potential for recreation or conservation use. Existing recreation facilities could be expanded and coordinated.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding

and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

wildlife habitat

Chuck S. Lebeda, wildlife management biologist, helped write this section.

Boone County supports a variety of wildlife species mainly in a greenbelt created by the intersection of the Des Moines River and its tributaries and predominantly agricultural land. Forest game species, including white-tailed deer, fox squirrel, grey fox, raccoon, and introduced stocks of wild turkey, inhabit the timbered river areas. Many songbirds and woodland birds, for example, bluejays, nuthatches, chickadees, thrushes, grosbeaks, woodpeckers, and warblers, inhabit the treetops in the forested areas.

The open agricultural land is inhabited by ring-necked pheasant, cottontail rabbit, meadowlarks, and field sparrows and by bobwhite quail where the agricultural land is adjacent to woodland. Wetland areas support a diversity of migrating waterfowl and some brood production of mallard, wood duck, and blue-winged teal. Shore birds, for example, plovers, killdeer, and sandpipers, also frequent these areas. Muskrat, mink, beaver, fox, coyote, and other furbearers are common in Boone County.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, orchardgrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, and elderberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, shore birds, muskrat, mink, and beaver.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about

kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 11 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be

expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil

layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering properties and classification provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. The ratings in table 12 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering properties and classification.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 13 gives information on the soil properties and site features that affect pond reservoir areas; embankments, dikes, and levees; drainage; irrigation; terraces and diversions; and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. The information in this table applies to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to unfavorable material affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering properties

Table 14 gives estimates of the engineering properties and classifications for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent.

Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

physical and chemical properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 15, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams and by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal

high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as rippable, if applicable. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*23*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 17, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed (calcareous), mesic Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*19*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*23*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Ames series

The Ames series consists of very poorly drained, very slowly permeable soils in depressions on uplands. These soils formed in local alluvium and glacial till. The slope ranges from 0 to 1 percent.

Ames soils are similar to Dundas soils and are commonly adjacent to Dundas and Luther soils on the landscape. Dundas soils have a thicker A1 horizon than that of Ames soils and have less clay in the B horizon. Luther soils have less clay in the B horizon and are in nearly level areas that are slightly higher in elevation than areas of the Ames soils.

Typical pedon of Ames silt loam, 0 to 1 percent slopes, 700 feet west and 30 feet south of the NE corner of sec. 36, T. 85 N., R. 27 W.

A1—0 to 3 inches; very dark brown (10YR 2/2) silt loam, gray (10YR 5/1) dry; continuous black (10YR 2/1) coatings on peds; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A21—3 to 6 inches; dark gray (10YR 4/1) silt loam, gray (10YR 6/1) dry; discontinuous very dark gray (10YR 3/1) coatings on peds; weak medium platy structure parting to weak very fine subangular blocky; friable; strongly acid; clear smooth boundary.

A22—6 to 11 inches; dark gray (10YR 4/1) silt loam, gray (10YR 6/1) dry; moderate medium platy structure parting to weak fine subangular blocky; friable; common medium iron and manganese concretions; strongly acid; gradual smooth boundary.

A23—11 to 17 inches; light brownish gray (10YR 6/2) silt loam, light gray (10YR 7/1) dry; weak very thick platy structure parting to moderate fine subangular blocky; friable; common medium iron and manganese concretions; strongly acid; abrupt smooth boundary.

B21tg—17 to 20 inches; gray (10YR 5/1) and grayish brown (10YR 5/2) clay loam; discontinuous light gray (10YR 7/1) dry silt coatings on peds; few fine distinct yellowish brown (10YR 5/4) mottles; strong fine angular blocky structure; firm; discontinuous moderately thick dark grayish brown (2.5Y 4/2) clay films on faces of peds; common medium iron and manganese concretions; strongly acid; clear smooth boundary.

B22tg—20 to 29 inches; gray (10YR 5/1) and grayish brown (2.5Y 5/2) clay; few fine distinct yellowish brown (10YR 5/4) mottles; strong medium angular blocky structure; firm; discontinuous moderately thick dark gray (10YR 4/1) clay films on faces of peds; common medium iron and manganese concretions; strongly acid; gradual smooth boundary.

B23tg—29 to 37 inches; grayish brown (2.5Y 5/2 & 10YR 5/2) clay loam; few medium prominent strong brown (7.5YR 5/6) mottles; moderate fine prismatic structure parting to strong fine angular blocky; firm; discontinuous moderately thick dark gray (10YR 4/1) and very dark gray (10YR 3/1) clay films on faces of peds; common medium iron and manganese concretions; medium acid; gradual smooth boundary.

B31tg—37 to 44 inches; gray (10YR 5/1) clay loam; discontinuous black (N 2/0) coatings in pores; many fine prominent strong brown (7.5YR 5/6) mottles; moderate very fine prismatic structure; very firm; discontinuous thick dark gray (10YR 4/1) clay films on faces of peds and in pores; many fine iron and manganese concretions; slightly acid; gradual smooth boundary.

B32tg—44 to 53 inches; gray (5Y 5/1) and grayish brown (2.5Y 5/2) clay loam; discontinuous black (N 2/0) coatings in pores; many medium prominent strong brown (7.5YR 5/6) mottles; strong fine angular blocky structure; very firm; discontinuous thick dark gray (10YR 4/1) clay films on faces of peds and in pores; many fine iron and manganese concretions; neutral; clear smooth boundary.

C1—53 to 58 inches; olive gray (5Y 5/2) loam; discontinuous black (N 2/0) coatings on peds and in pores; many medium prominent strong brown (7.5YR 5/6) and red (2.5YR 4/8) mottles; massive; firm; many fine iron and manganese concretions; neutral; clear smooth boundary.

C2—58 to 60 inches; mottled gray (5Y 5/1) and strong brown (7.5YR 5/6 & 5/8) loam; black (N 2/0) coatings on cleavage planes; massive; friable; many fine iron, manganese, and calcium carbonate concretions; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 36 to 60 inches.

The A1 horizon has color value of 2 through 4 and chroma of 1 or 2. It is loam or silt loam. The A2 horizon has value of 4 through 6 and chroma of 1 or 2. The B2tg horizon has hue of 10YR through 5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam or clay. Reaction is strongly acid or medium acid.

Biscay series

The Biscay series consists of poorly drained soils that are moderately permeable in the solum and rapidly permeable in the substratum. The soils are on stream benches. They formed in loamy alluvium that is underlain by sand and gravel at a depth of 32 to 40 inches. The slope ranges from 0 to 2 percent.

Biscay soils are similar to and commonly adjacent on the landscape to Cylinder, Linder, and Talcot soils. Cylinder soils are somewhat poorly drained. Linder soils have less clay in the upper part of the subsoil. Talcot soils have free carbonates within 10 inches of the surface.

Typical pedon of Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, 110 feet west and 438 feet north of the SE corner of sec. 29, T. 84 N., R. 28 W.

Ap—0 to 8 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; moderate fine subangular blocky structure parting to moderate fine granular; friable; mildly alkaline; clear smooth boundary.

A12—8 to 13 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure parting to moderate fine granular; friable; mildly alkaline; clear smooth boundary.

A3—13 to 17 inches; very dark gray (5Y 3/1) clay loam, dark gray (5Y 4/1) dry; few fine prominent strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure parting to moderate fine

granular; friable; mildly alkaline; clear smooth boundary.

B21g—17 to 21 inches; olive gray (5Y 4/2) clay loam; discontinuous very dark gray (5Y 3/1) coatings on peds; many medium prominent yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure parting to moderate fine granular; friable; mildly alkaline; clear smooth boundary.

B22g—21 to 26 inches; olive gray (5Y 5/2) clay loam; discontinuous very dark gray (5Y 3/1) coatings on peds; many medium prominent yellowish brown (10YR 5/6) mottles; moderate fine granular structure; friable; mildly alkaline; abrupt smooth boundary.

B3g—26 to 36 inches; mixed olive gray (5Y 5/2), olive (5Y 5/3), and gray (5Y 6/1) sandy clay loam; weak medium subangular blocky structure parting to single grained; very friable; slight effervescence; disseminated lime; moderately alkaline; clear smooth boundary.

IIC1g—36 to 42 inches; gray (5Y 6/1) gravelly sand; single grained; loose; strong effervescence; disseminated lime; moderately alkaline; clear smooth boundary.

IIC2g—42 to 60 inches; light olive gray (5Y 6/2) gravelly sand; single grained; loose; strong effervescence; disseminated lime; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 32 to 40 inches. Some pedons do not have free carbonates in the B3 horizon. The depth to sand and gravel ranges from 32 to 40 inches. The thickness of the mollic epipedon ranges from 16 to 24 inches.

The A horizon has neutral color, or it has hue of 10YR or 2.5Y, value of 2, and chroma of 1 or less. It ranges from sandy loam to clay loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It ranges from loam to clay loam in the upper part. The lower part of the B horizon extends a few inches into the contrasting material in some pedons. The reaction typically is neutral but commonly is mildly alkaline in the lower part. The C horizon is sand that has a variable amount of gravel.

Blue Earth series

The Blue Earth series consists of very poorly drained, moderately permeable calcareous soils in concave upland depressions. The soils formed in sediment high in organic matter and underlain by glacial till. The slope ranges from 0 to 1 percent. These soils have less organic matter than that in the defined range for the series; however, this difference does not significantly affect the use and management of the soils.

Blue Earth soils are similar to Okoboji and Palms soils. The Okoboji soils have less organic matter in the A horizon and typically do not have carbonates in the A horizon. Palms soils have sapric material at least 20 inches thick.

Typical pedon of Blue Earth mucky silt loam, 0 to 1 percent slopes, 2,511 feet south and 600 feet west of the NE corner of sec. 11, T. 85 N., R. 25 W.

Ap—0 to 8 inches; black (N 2/0) mucky silt loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to moderate medium granular; friable; strong effervescence; moderately alkaline; clear smooth boundary.

A12—8 to 13 inches; black (N 2/0) mucky loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to weak medium granular; friable; slight effervescence; moderately alkaline; clear smooth boundary.

A13—13 to 22 inches; black (N 2/0) mucky loam, dark gray (10YR 4/1) dry; weak coarse subangular blocky structure parting to moderate medium granular; friable; slight effervescence; moderately alkaline; gradual smooth boundary.

A14—22 to 27 inches; black (N 2/0) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; slight effervescence; moderately alkaline; gradual smooth boundary.

A15—27 to 32 inches; black (N 2/0) silt loam, dark gray (10YR 4/1) dry; common medium prominent strong brown (7.5YR 5/8) mottles along root channels; moderate medium subangular blocky structure; friable; moderately alkaline; gradual smooth boundary.

A16—32 to 40 inches; black (N 2/0) loam, dark gray (10YR 4/1) dry, few fine prominent strong brown (7.5YR 5/8) mottles along root channels; moderate medium subangular blocky structure; friable; common pebbles; moderately alkaline; clear smooth boundary.

Bg—40 to 44 inches; black (10YR 2/1) silty clay loam, common large distinct dark grayish brown (10YR 4/2) mottles; weak medium subangular blocky structure; friable; moderately alkaline; clear smooth boundary.

Cg—44 to 60 inches; gray (5Y 5/1) silty clay loam, common medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; few fine iron and manganese concretions; strong effervescence; moderately alkaline.

The solum is 36 to 48 inches thick. The thickness of material high in organic matter ranges from 16 to 22 inches. The thickness of the mollic epipedon ranges from 32 to 48 inches.

The A horizon is 10 to 25 percent organic matter. It ranges from mucky silt loam in the upper part to loam in the lower part. It has hue of 10YR to 5Y, value of 2 or 3, and chroma of 2 or less. Reaction is mildly alkaline or moderately alkaline.

Buckney series

The Buckney series consists of excessively drained, moderately rapidly permeable calcareous soils on bottom lands. These soils formed in mixed, loamy and sandy alluvium. The slope ranges from 0 to 13 percent.

Buckney soils are similar to Hanlon soils and are associated with Hanlon and Spillville soils. Hanlon soils are cumulic, and Spillville soils have less sand in the solum.

Typical pedon of Buckney fine sandy loam, 1 to 3 percent slopes, 420 feet east and 1,050 feet south of the NW corner of sec. 21, T. 83 N., R. 26 W.

A11—0 to 5 inches; very dark brown (10YR 2/2) fine sandy loam, grayish brown (2.5Y 5/2) dry; moderate fine subangular blocky structure parting to moderate fine granular; friable; slight effervescence; moderately alkaline; abrupt smooth boundary.

A12—5 to 12 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (2.5Y 5/2) dry; moderate medium subangular blocky structure; friable; slight effervescence; clear smooth boundary.

A13—12 to 17 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) fine sandy loam, grayish brown (2.5Y 5/2) dry; moderate fine subangular blocky structure; very friable; slight effervescence; moderately alkaline; clear smooth boundary.

C1—17 to 28 inches; brown (10YR 5/3) loamy sand; massive; loose; slight effervescence; mildly alkaline; clear smooth boundary.

C2—28 to 38 inches; brown (10YR 4/3) and dark grayish brown (10YR 4/2) fine sandy loam; massive; very friable; strong effervescence; moderately alkaline; gradual smooth boundary.

C3—38 to 48 inches; brown (10YR 4/3) and dark grayish brown (10YR 4/2) fine sandy loam; massive; very friable; slight effervescence; moderately alkaline; gradual smooth boundary.

C4—48 to 60 inches; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) sandy loam; massive; friable; slight effervescence; moderately alkaline.

The solum and the mollic epipedon are 10 to 24 inches thick.

The A horizon has color value of 2 or 3 and chroma of 2 or 3. It ranges from silt loam or loam to loamy fine sand. The control section is less than 18 percent clay throughout. Below the mollic epipedon value is 4 or 5 and chroma is 3. Reaction is mildly alkaline or moderately alkaline.

Calco series

The Calco series consists of poorly drained, moderately permeable, calcareous soils on flood plains. They formed in silty and loamy alluvium derived from glacial till. The slope ranges from 0 to 2 percent. These soils have more sand throughout than is defined for the series; however, this difference does not significantly affect the use and management of the soils.

Calco soils are similar to Canisteo soils and are commonly adjacent to Coland soils in the landscape. Canisteo soils have a mollic epipedon less than 24 inches thick. Coland soils do not have free carbonates in the solum.

Typical pedon of Calco silty clay loam, 0 to 2 percent slopes, 10 feet north and 1,470 feet west of the SE corner of sec. 4, T. 84 N., R. 28 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

A12—8 to 12 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; moderate fine granular structure; friable; very slight effervescence; moderately alkaline; gradual smooth boundary.

A13—12 to 22 inches; black (10YR 2/1) clay loam, very dark gray (N 3/0) dry; continuous black (N 2/0) coatings on peds; moderate medium subangular blocky structure parting to moderate fine granular; friable; very slight effervescence; moderately alkaline; gradual smooth boundary.

A14—22 to 28 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; continuous black (N 2/0) coatings on peds; moderate very fine angular blocky structure; friable; very slight effervescence; moderately alkaline; gradual smooth boundary.

A15—28 to 33 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine angular blocky structure; friable; very slight effervescence; moderately alkaline; gradual smooth boundary.

B1g—33 to 37 inches; very dark gray (10YR 3/1) clay loam; continuous black (10YR 2/1) coatings on peds; few fine distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; very slight effervescence; moderately alkaline; gradual smooth boundary.

B2g—37 to 45 inches; dark gray (5Y 4/1) clay loam; discontinuous very dark gray (10YR 3/1) coatings on peds; common fine distinct brownish yellow (10YR 6/8) mottles; moderate medium subangular blocky structure; friable; few fine iron concretions; slight effervescence; moderately alkaline; gradual smooth boundary.

C1g—45 to 57 inches; olive gray (5Y 5/2) clay loam, few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; few fine iron concretions; slight effervescence; moderately alkaline; clear smooth boundary.

C2g—57 to 60 inches; gray (5Y 6/1) clay loam; few large distinct gray (N 5/0) and few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; few fine

iron concretions; very slight effervescence; moderately alkaline.

The solum is 36 to 60 inches thick. The mollic epipedon is 30 to 50 inches thick.

The A horizon is neutral color, or it has hue of 10YR and chroma of 1 or less. It is silty clay loam high in sand or clay loam. The Bg horizon is neutral color, or it has hue of 10YR, value of 3 or 4, and chroma of 1 or less and has few or common mottles. It is silty clay loam high in sand or clay loam. Reaction is mildly or moderately alkaline. The C horizon is silty clay loam high in sand or clay loam.

Canisteo series

The Canisteo series consists of poorly drained, moderately permeable calcareous soils on uplands. The soils formed in glacial sediment and loamy glacial till. The slope ranges from 0 to 2 percent.

Canisteo soils are similar to Harps and Webster soils and are commonly adjacent to Harps and Nicollet soils on the landscape. The Harps soils have a calcic horizon. The Nicollet and Webster soils have a noncalcareous solum.

Typical pedon of Canisteo silty clay loam, 0 to 2 percent slopes, 1,240 feet north and 160 feet east of the SW corner of sec. 32, T. 83 N., R. 25 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak medium granular; friable; strong effervescence; moderately alkaline; clear smooth boundary.

A12—8 to 13 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate fine granular; friable; strong effervescence; moderately alkaline; gradual wavy boundary.

A13—13 to 18 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; black (10YR 2/1) coatings on peds; weak medium subangular blocky structure parting to moderate fine granular; friable; strong effervescence; moderately alkaline; clear wavy boundary.

B1—18 to 26 inches; dark gray (5Y 4/1) clay loam; very dark gray (5Y 3/1) coatings on peds; moderate medium angular blocky structure parting to moderate medium granular; friable; slight effervescence; moderately alkaline; clear wavy boundary.

B2G—26 to 30 inches; olive gray (5Y 5/2) clay loam; discontinuous very dark gray (5Y 3/1) coatings on peds; few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium angular blocky structure parting to weak medium granular; friable; strong effervescence; moderately alkaline; clear wavy boundary.

B3—30 to 36 inches; pale olive (5Y 6/3) loam; discontinuous black (5Y 2.5/1) coatings on peds; common fine prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; few manganese and iron concretions; strong effervescence; moderately alkaline; clear wavy boundary.

C1g—36 to 48 inches; light olive gray (5Y 6/2) loam; common fine prominent strong brown (7.5YR 5/6) mottles; massive; friable; few manganese and iron concretions; strong effervescence; moderately alkaline; clear wavy boundary.

C2g—48 to 60 inches; light olive gray (5Y 6/2) loam; many medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; few manganese and iron concretions; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 36 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches.

The A horizon has color hue of 10YR to 5Y, value of 2 or 3, and chroma of 1 or less. It ranges from loam to silty clay loam. The B2 horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It ranges from loam to silty clay loam.

Clarion series

The Clarion series consists of well drained, moderately permeable soils on uplands. The soils formed in loamy glacial till. The slope ranges from 2 to 14 percent.

Clarion soils are similar to Lester, Wadena, and Zenor soils. Lester soils have an argillic horizon. Wadena soils have contrasting textures of sand and gravel within a depth of 40 inches and are on stream benches. Zenor soils have a coarse-loamy control section and formed in glacial outwash material.

Typical pedon of Clarion loam, 2 to 5 percent slopes, 270 feet north and 620 feet west of the SE corner of sec. 7, T. 83 N., R. 25 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; moderate fine granular structure; friable; neutral; clear smooth boundary.

A12—8 to 12 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; friable; neutral; gradual smooth boundary.

B1—12 to 18 inches; dark brown (10YR 3/3) loam; very dark brown (10YR 2/2) coatings on peds; moderate medium angular blocky structure parting to moderate fine granular; friable; slightly acid; clear smooth boundary.

B21—18 to 25 inches; brown (10YR 4/3) loam; very dark grayish brown (10YR 3/2) coatings on peds; moderate medium subangular blocky structure; friable; neutral; clear smooth boundary.

B22—25 to 36 inches; yellowish brown (10YR 5/4) loam; dark brown (10YR 3/3) coatings on peds; moderate

medium subangular blocky structure; friable; neutral; clear smooth boundary.

B23—36 to 40 inches; brown (10YR 5/3) loam; many medium prominent strong brown (7.5YR 5/6) and common fine distinct yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; friable; mildly alkaline; clear smooth boundary.

C1—40 to 45 inches; light yellowish brown (10YR 6/4) loam; common fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; few manganese oxides and calcium carbonate concretions; slight effervescence; moderately alkaline; clear smooth boundary.

C2—45 to 60 inches; mottled pale brown (10YR 6/3) and strong brown (7.5YR 5/6) loam; light gray (10YR 7/2) streaks; massive; friable; few manganese and calcium carbonate concretions; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 45 inches. The thickness of the mollic epipedon ranges from 6 to 18 inches.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. It ranges from sandy loam to clay loam. The B2 horizon has value of 4 or 5 and chroma of 3 or 4. It ranges from sandy loam to clay loam. Reaction is slightly acid to mildly alkaline.

Coland series

The Coland series consists of poorly drained, moderately permeable soils on bottom lands. The soils formed in loamy alluvium. The slope ranges from 0 to 5 percent.

Coland soils are similar to and are commonly adjacent to Calco and Spillville soils. Calco soils have carbonates within 10 inches of the surface. Spillville soils have more sand and less clay in the control section.

Typical pedon of Coland clay loam, 0 to 2 percent slopes, 117 feet south and 1,760 feet east of the NW corner of sec. 22, T. 84 N., R. 28 W.

A11—0 to 9 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to moderate medium granular; friable; neutral; gradual smooth boundary.

A12—9 to 16 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; continuous black (N 2/0) coatings on peds; moderate medium subangular blocky structure; friable; neutral; gradual smooth boundary.

A13—16 to 22 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to moderate medium granular; friable; neutral; clear smooth boundary.

A14—22 to 34 inches; black (5Y 2.5/1) clay loam, very dark gray (5Y 3/1) dry; discontinuous black (10YR 2/1) coatings on peds; moderate medium subangular blocky structure; firm; neutral; clear smooth boundary.

AC—34 to 41 inches; black (5Y 2.5/1) clay loam, very dark gray (5Y 3/1) dry; discontinuous black (N 2/0) coatings on peds; weak medium angular blocky structure; firm; few iron concretions; neutral; clear smooth boundary.

C1g—41 to 50 inches; black (5Y 2.5/1) clay loam; discontinuous black (N 2/0) coatings on peds; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium angular blocky structure; firm; many iron concretions; neutral; gradual smooth boundary.

C2g—50 to 60 inches; black (5Y 2.5/1) clay loam; discontinuous black (N 2/0) coatings on peds; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium angular blocky structure; firm; neutral.

The thickness of the solum ranges from 36 to 48 inches. The depth to free carbonates is more than 48 inches. The thickness of the mollic epipedon is at least 36 inches.

The A horizon has color value of 2 or 3 and chroma of 1 or less. It ranges from loam to clay loam or silty clay loam high in sand. The upper 10 inches is loam in some pedons. Reaction is slightly acid or neutral. The C horizon has hue of 2.5Y or 5Y, value of 2 to 5, and chroma of 1. It is loam or clay loam. Sand strata are present below a depth of 48 inches in places.

Crippin series

The Crippin series consists of somewhat poorly drained, moderately permeable calcareous soils on uplands. The soils formed in glacial till. The slope ranges from 1 to 3 percent.

Crippin soils are similar to and are associated with Canisteo and Nicollet soils. Canisteo soils are poorly drained and have a grayer subsoil. Nicollet soils are not calcareous.

Typical pedon of Crippin loam, 1 to 3 percent slopes, 477 feet north and 1,295 feet east of the center of sec. 15, T. 82 N., R. 28 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to weak medium granular; friable; slight effervescence; mildly alkaline; clear smooth boundary.

A12—8 to 15 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; continuous black (10YR 2/1) coatings on peds; weak medium granular structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

A3—15 to 18 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; discontinuous very dark gray (10YR 3/1) coatings

on peds; weak medium subangular blocky structure parting to weak medium granular; friable; strong effervescence; moderately alkaline; clear smooth boundary.

B2—18 to 24 inches; dark grayish brown (10YR 4/2) loam; discontinuous very dark gray (10YR 3/1) coatings on peds; common fine distinct brown (10YR 5/3) mottles; weak medium to fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

B3—24 to 30 inches; grayish brown (10YR 5/2) loam; discontinuous very dark gray (10YR 3/1) coatings on peds; few fine distinct yellowish brown (10YR 5/4) and few medium distinct gray (10YR 6/1) mottles; weak medium subangular blocky structure; friable; strong effervescence; moderately alkaline; few calcium carbonate and iron concretions; gradual smooth boundary.

C1—30 to 43 inches; grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) loam; few fine prominent yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline; many calcium carbonate and iron concretions; gradual smooth boundary.

C2—43 to 60 inches; grayish brown (2.5Y 5/2) loam; common fine prominent strong brown (7.5YR 5/6) mottles; massive; friable; strong effervescence; moderately alkaline; many calcium carbonate, iron, and manganese concretions.

The thickness of the solum ranges from 20 to 48 inches. The thickness of the mollic epipedon ranges from 14 to 20 inches.

The A horizon is neutral, or it has hue of 10 YR, value of 2 or 3, and chroma of 1 or 2. It ranges from loam to clay loam. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2. It is loam or clay loam. Reaction is mildly or moderately alkaline. The calcium carbonate equivalent in the 10- to 40-inch control section ranges from 5 to 20 percent.

Cylinder series

The Cylinder series consists of somewhat poorly drained soils. The soils are moderately permeable in the solum and very rapidly permeable in the substratum. They are on stream benches and formed in loamy alluvium that is underlain by sand and gravel at a depth of 32 to 40 inches. The slope ranges from 0 to 2 percent.

Cylinder soils are similar to Biscay, Linder, and Nicollet soils and are commonly adjacent to Biscay and Linder soils on the landscape. Biscay soils have colors of lower chroma below the mollic epipedon. Linder soils have more sand in the B horizon and a coarse-loamy control section. Nicollet soils have less sand throughout and a fine-loamy control section.

Typical pedon of Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, 500 feet west and 576 feet north of the SE corner of sec. 33, T. 83 N., R. 28 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; neutral; gradual smooth boundary.

A12—8 to 17 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A3—17 to 24 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure parting to weak fine subangular blocky; friable; slightly acid; clear smooth boundary.

B21—24 to 31 inches; dark grayish brown (10YR 4/2) loam, high in content of sand; discontinuous very dark brown (10YR 2/2) coatings on peds; weak medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

B22—31 to 35 inches; dark grayish brown (10YR 4/2) sandy loam; discontinuous very dark grayish brown (10YR 3/2) coatings on peds; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.

IIC1—35 to 40 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) loamy coarse sand; single grained; loose; very slight effervescence; mildly alkaline; abrupt smooth boundary.

IIC2—40 to 51 inches; dark grayish brown (10YR 4/2) coarse sand; single grained; loose; strong effervescence; moderately alkaline; abrupt smooth boundary.

IIC3—51 to 60 inches; brown (7.5YR 5/4) coarse sand; single grained; loose; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 32 to 48 inches. The depth to carbonates ranges from 30 to 60 inches. The depth to sand and gravel ranges from 24 to 40 inches. In most pedons, it is 32 to 40 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches.

The A horizon has color value of 2 and chroma of 1 or 2. It is loam or clay loam. The B2 horizon has value of 4 or 5 and chroma of 2. It is typically loam but ranges from sandy loam to clay loam. The lower part of the B horizon extends into the contrasting material in some pedons. Reaction is slightly acid or neutral. The C horizon is sand that has various amounts of gravel.

Dickman series

The Dickman series consists of well drained, rapidly permeable soils on uplands and stream benches. The soils formed in eolian sand. The slope ranges from 1 to 9 percent.

Dickman soils are similar to Zenor soils and are commonly adjacent to Clarion and Zenor soils on the landscape. Clarion soils have a fine-loamy control section and are typically in higher positions on the landscape. Zenor soils have coarse sand and gravel throughout the profile and are typically in higher positions on the landscape.

Typical pedon of Dickman fine sandy loam, 1 to 5 percent slopes, 1,795 feet north and 525 feet east of the SW corner of sec. 32, T. 84 N., R. 28 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) fine sandy loam, very dark grayish brown (10YR 3/2) dry; continuous black (10YR 2/1) coatings on peds; cloddy parting to weak medium granular structure; very friable; slightly acid; clear smooth boundary.

A12—8 to 16 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; continuous very dark brown (10YR 2/2) coatings on peds; weak fine subangular blocky structure parting to moderate fine granular; very friable; slightly acid; clear smooth boundary.

B1—16 to 20 inches; dark brown (10YR 3/3) sandy loam, brown (10YR 4/3) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on peds; weak fine and very fine subangular blocky structure; very friable; slightly acid; gradual smooth boundary.

B21—20 to 29 inches; mixed dark brown (10YR 3/3) and brown (10YR 4/3) loamy sand; moderate medium subangular blocky structure parting to moderate fine subangular blocky; very friable; slightly acid; gradual smooth boundary.

B22—29 to 39 inches; dark yellowish brown (10YR 4/4) loamy sand; moderate fine subangular blocky structure; very friable; slightly acid; gradual smooth boundary.

B3—39 to 50 inches; mixed dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) loamy sand; weak very fine subangular blocky structure; very friable; slightly acid; clear smooth boundary.

C1—50 to 57 inches; dark yellowish brown (10YR 4/4) sandy loam; common medium prominent yellowish red (5YR 5/8) and few fine faint yellowish brown (10YR 5/4) relict mottles; weak coarse subangular blocky structure parting to single grained; very friable; slightly acid; clear smooth boundary.

C2—57 to 60 inches; grayish brown (2.5Y 5/2) loamy sand and silt loam; many coarse prominent strong brown (7.5YR 5/8) relict mottles; single grained and massive; very friable and loose; thin iron bands; slighty acid.

The thickness of the solum ranges from 30 to 50 inches. The depth to loamy sand and sand ranges from 20 to 40 inches. The depth to free carbonates is more than 60 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has color value of 2 or 3 and chroma of 3 or less. It ranges from fine sandy loam to loam. The B2 horizon has value of 4 or 5 and chroma of 4 through 6. It ranges from loamy sand to fine sandy loam. The lower part of the B horizon typically has a higher content of sand than the upper part. Reaction ranges from slightly acid to strongly acid. The C horizon is loamy sand or sand.

Dundas series

The Dundas series consists of poorly drained, moderately slowly permeable soils in swales on uplands. The soils formed in local alluvium and glacial till. The slope ranges from 0 to 2 percent.

Dundas soils are similar and are commonly adjacent to Ames and Luther soils on the landscape. Ames soils have a thinner A1 horizon and a fine textured argillic horizon. Luther soils have hue of 10YR in the upper part of the argillic horizon.

Typical pedon of Dundas silt loam, 0 to 2 percent slopes, 700 feet west and 1,500 feet south of the NE corner of sec. 2, T. 84 N., R. 27 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.

A2—7 to 10 inches; grayish brown (10YR 5/2) silt loam, light brownish gray (10YR 6/2) dry; discontinuous very dark gray (10YR 3/1) coatings on peds; weak medium subangular blocky structure parting to moderate very fine subangular blocky; friable; strongly acid; clear smooth boundary.

B1tg—10 to 14 inches; grayish brown (2.5Y 5/2) silty clay loam; moderate fine subangular blocky structure parting to weak very fine subangular blocky; firm; gray (10YR 6/1) uncoated silt and very fine sand grains on faces of peds; discontinuous thin clay films on faces of peds; strongly acid; clear smooth boundary.

B21tg—14 to 22 inches; olive gray (5Y 5/2) clay loam; few fine faint yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; very firm; discontinuous moderately thick clay films on faces of peds and in pores; strongly acid; gradual smooth boundary.

B22tg—22 to 35 inches; olive (5Y 5/3) clay loam; many medium faint olive gray (5Y 5/2) and few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium angular blocky structure; very firm; continuous thick clay films on faces of peds and in pores; slightly acid; clear smooth boundary.

C1—35 to 48 inches; light olive gray (5Y 6/2) loam; many medium prominent brownish yellow (10YR 6/8) and few medium distinct olive (5Y 5/4) mottles; massive; friable; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—48 to 60 inches; mottled brownish yellow (10YR 6/8), light olive gray (5Y 6/2), and olive (5Y 5/3)

loam; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 48 inches.

The A horizon has color value of 2 or 3 and chroma of 1. It ranges from loam to silty clay loam. The A2 horizon has value of 4 or 5 and chroma of 1 or 2. Its texture is the same as the A1 horizon. The B2t horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 through 3. It is dominantly clay loam. In some pedons the subhorizons are clay. Reaction ranges from slightly acid to strongly acid in the upper part and from medium acid to neutral in the lower part.

Guckeen series

The Guckeen series consists of somewhat poorly drained, slowly permeable soils on uplands. The soils formed in loamy and clayey sediment and in the underlying glacial till. The slope ranges from 1 to 4 percent.

Guckeen soils are similar to Marna and Nicollet soils and are commonly adjacent to Marna soils on the landscape. Marna soils have colors of lower chroma or distinct or prominent mottles directly below the mollic epipedon. Nicollet soils have less clay in the upper part of the solum and a fine-loamy control section.

Typical pedon of Guckeen clay loam, 1 to 4 percent slopes, 500 feet east and 780 feet north of the center of sec. 4, T. 85 N., R. 28 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; neutral; clear smooth boundary.

A12—8 to 18 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; continuous black (10YR 2/1) coatings on peds and in pores; weak fine subangular blocky structure parting to moderate fine granular; friable; neutral; gradual smooth boundary.

B1—18 to 23 inches; dark grayish brown (10YR 4/2) silty clay loam; continuous very dark gray (10YR 3/1) coatings on peds and in pores; weak fine subangular blocky structure parting to moderate very fine subangular blocky; friable; neutral; clear smooth boundary.

B21t—23 to 30 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure parting to moderate fine subangular blocky; firm; discontinuous moderately thick very dark gray (10YR 3/1) clay films on faces of peds and in pores; slightly acid; gradual smooth boundary.

B22t—30 to 36 inches; dark grayish brown (2.5Y 4/2) silty clay loam; few fine distinct strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure parting to moderate fine subangular blocky; very firm discontinuous moderately thick dark gray (5Y 4/1) clay films on faces of peds and in pores; slightly acid; gradual smooth boundary.

IIB3t—36 to 41 inches; grayish brown (2.5Y 5/2) loam; common medium prominent yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure parting to moderate fine subangular blocky; friable; discontinuous moderately thick olive gray (5Y 4/2) clay films on faces of peds and in pores; neutral; gradual smooth boundary.

IIC1—41 to 52 inches; grayish brown (2.5Y 5/2) loam; many medium prominent yellowish brown (10YR 5/8) and common medium distinct light gray (10YR 7/2) mottles; weak medium subangular blocky structure; friable; strong effervescence; mildly alkaline; clear wavy boundary.

IIC2—52 to 60 inches; yellowish brown (10YR 5/4) loam; few fine distinct yellowish red (5YR 5/8) common medium distinct gray (5Y 5/1) and few fine distinct light brownish gray (10YR 6/2) mottles; massive; friable; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 44 inches. The depth to the underlying glacial till ranges from 24 to 36 inches. The thickness of the mollic epipedon ranges from 12 to 24 inches.

The A horizon has color value of 2 or 3 and chroma of 1. It is silty clay loam, clay loam, or silty clay. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2. The upper part of the B horizon is clay loam, silty clay loam, or silty clay. Reaction is medium acid to neutral. The IIC horizon is loam or clay loam.

Hanlon series

The Hanlon series consists of moderately well drained, moderately rapidly permeable soils on natural levees and bottom lands. The soils formed in loamy alluvium. The slope ranges from 0 to 2 percent.

Hanlon soils are similar to Spillville soils and are commonly adjacent to Buckney and Spillville soils on the landscape. Buckney soils have a mollic epipedon less than 24 inches thick. Spillville soils are fine-loamy.

Typical pedon of Hanlon fine sandy loam, 0 to 2 percent slopes, 1,250 feet north and 150 feet east of the SW corner of sec. 31, T. 84 N., R. 26 W.

A11—0 to 8 inches; black (10YR 2/1) fine sandy loam; dark gray (10YR 4/1) dry; weak medium subangular blocky structure; very friable; neutral; gradual smooth boundary.

A12—8 to 24 inches; very dark brown (10YR 2/2) fine sandy loam, dark gray (10YR 4/1) dry; continuous black (10YR 2/1) coatings on peds; weak medium subangular blocky structure; very friable; neutral; gradual smooth boundary.

A13—24 to 34 inches; very dark grayish brown (10YR 3/2) fine sandy loam; continuous very dark brown

(10YR 2/2) coatings on peds; weak medium subangular blocky structure; very friable; neutral; gradual smooth boundary.

A3—34 to 43 inches; very dark grayish brown (10YR 3/2) fine sandy loam; discontinuous very dark brown (10YR 2/2) coatings on peds; weak medium subangular blocky structure; very friable; neutral; gradual smooth boundary.

B2—43 to 50 inches; dark brown (10YR 3/3) fine sandy loam; discontinuous very dark grayish brown (10YR 3/2) coatings on peds; weak medium subangular blocky structure; very friable; neutral; gradual smooth boundary.

B3—50 to 60 inches; dark brown (10YR 3/3) fine sandy loam; discontinuous very dark grayish brown (10YR 3/2) coating on peds; weak medium subangular blocky structure; very friable; neutral.

The thickness of the solum ranges from 40 to 72 inches. The depth to free carbonates is more than 4 feet. The thickness of the mollic epipedon ranges from 40 to 70 inches.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. It is fine sandy loam or sandy loam. The B horizon has value of 3 or 4 and chroma of 2 or 3. It is fine sandy loam or sandy loam.

Harcot series

The Harcot series consists of poorly drained, calcareous soils on stream terraces. The soils are moderately permeable in the solum and very rapidly permeable in the substratum. They formed in loamy alluvium underlain by sand and gravel at a depth of 24 to 40 inches. The slope ranges from 0 to 2 percent.

Harcot soils are similar to Harps and Talcot soils. Harps soils have less sand in the lower part of the profile and have a fine-loamy control section. Talcot soils do not have a calcic horizon.

Typical pedon from an area of Harcot loam, 0 to 2 percent slopes, 735 feet south and 393 feet west of the NE corner of sec. 32, T. 84 N., R. 28 W.

Apca—0 to 7 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; discontinuous black (10YR 2/1) coatings on peds; weak medium subangular blocky structure parting to weak medium granular; friable; violent effervescence; moderately alkaline; clear smooth boundary.

A12ca—7 to 14 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; continuous black (10YR 2/1) coatings on peds; moderate medium subangular blocky structure; friable; violent effervescence; moderately alkaline; clear smooth boundary.

B21gca—14 to 19 inches; dark grayish brown (2.5Y 4/2) sandy clay loam; discontinuous very dark gray (10YR 3/1) coatings on peds; few fine distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; very friable; violent effervescence; moderately alkaline; clear smooth boundary.

B22gca—19 to 24 inches; olive gray (5Y 5/2) gravelly sandy clay loam; discontinuous dark gray (5Y 4/1) coatings on peds; weak medium subangular blocky structure; very friable; violent effervescence; moderately alkaline; clear smooth boundary.

B23—24 to 30 inches; olive (5Y 5/3) gravelly sandy clay loam; weak fine subangular blocky structure; very friable; slight effervescence; moderately alkaline; clear smooth boundary.

B24—30 to 34 inches; olive (5Y 5/3) gravelly sandy clay loam; weak fine subangular blocky structure; very friable; strong effervescence; moderately alkaline; clear smooth boundary.

IIC1—34 to 38 inches; olive (5Y 5/3) gravelly loamy sand; single grained; loose; strong effervescence; moderately alkaline; abrupt smooth boundary.

IIC2—38 to 60 inches; light olive gray (5Y 6/2) gravelly sand; single grained; loose; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to sand and gravel range from 24 to 40 inches. The thickness of the mollic epipedon ranges from 14 to 24 inches.

The A horizon is neutral, or it has hue of 10YR, value of 2 or 3, and chroma of 1 or less. It ranges from silt loam high in sand to clay loam. The B horizon has hue of 10YR through 5Y, value of 4 or 5, and chroma of 1, 2, or 3. It is loam, clay loam, or sandy clay loam. Reaction is mildly or moderately alkaline. The IIC horizon is stratified in most pedons and ranges from fine sand to gravelly coarse sand.

Harps series

The Harps series consists of poorly drained, moderately permeable calcareous soils along edges of depressions on uplands. The soils formed in loamy glacial till. The slope ranges from 0 to 2 percent.

Harps soils are similar to Blue Earth and Canisteo soils and are commonly adjacent to Blue Earth, Canisteo, Okoboji, Palms, and Webster soils on the landscape. Blue Earth and Canisteo soils have less than 15 percent calcium carbonate equivalent. Okoboji soils have a fine textured control section and less than 15 percent calcium carbonate equivalent. Palms soils have a histic epipedon and less than 15 percent calcium carbonate equivalent. Webster soils are more than 20 inches to free carbonates and less than 15 percent calcium carbonate equivalent.

Typical pedon of Harps loam, 0 to 2 percent slopes, 285 feet west and 2,585 feet south of the NE corner of sec. 11, T. 85 N., R. 25 W.

Apca—0 to 7 inches; black (N 2/0) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure parting to moderate medium granular; friable; 17 percent calcium carbonate equivalent; violent effervescence; moderately alkaline; clear smooth boundary.

A12ca—7 to 12 inches; black (N 2/0) loam, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; 23 percent calcium carbonate equivalent; violent effervescence; moderately alkaline; clear smooth boundary.

A13ca—12 to 22 inches; very dark gray (5Y 3/1) loam, dark gray (5Y 4/1) dry; weak medium subangular blocky structure parting to moderate medium granular; friable; 15 percent calcium carbonate equivalent; violent effervescence; moderately alkaline; clear smooth boundary.

B1ca—22 to 27 inches; dark gray (5Y 4/1) loam; very dark gray (N 3/0) coatings on peds; moderate medium subangular blocky structure; friable; 15 percent calcium carbonate equivalent; violent effervescence; moderately alkaline; clear smooth boundary.

B21ca—27 to 32 inches; gray (5Y 5/1) loam; common fine prominent strong brown (7.5YR 5/8), few fine faint light gray (5Y 7/1) and dark gray (5Y 4/1) mottles; moderate medium subangular blocky structure; friable; 16 percent calcium carbonate equivalent; few fine segregated lime concretions; violent effervescence; moderately alkaline; clear smooth boundary.

B22ca—32 to 43 inches; gray (5Y 5/1) loam; common medium prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; 19 percent calcium carbonate equivalent; few fine manganese and lime concretions; violent effervescence; moderately alkaline; clear smooth boundary.

B3ca—43 to 54 inches; mottled gray (5Y 5/1) and strong brown (7.5YR 5/6) loam; weak medium subangular blocky structure; friable; 24 percent calcium carbonate equivalent; few fine manganese and lime concretions; violent effervescence; moderately alkaline; clear smooth boundary.

C—54 to 60 inches; gray (5Y 5/1) loam; few fine distinct light olive gray (5Y 6/2) and yellowish brown (10YR 5/4) mottles; massive; friable; 21 percent calcium carbonate equivalent; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 54 inches. The thickness of the mollic epipedon ranges from 10 to 22 inches. The calcium carbonate equivalent ranges from 15 to 40 percent.

The A horizon has color value of 2 or 3 and chroma of 1 or less. It is loam or light clay loam. The B2 horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2.

Hayden series

The Hayden series consists of well drained, moderately permeable soils on upland ridges and side slopes. The soils formed in loamy glacial till. The slope ranges from 2 to 50 percent.

Hayden soils are similar to Lester soils and are commonly adjacent to Luther soils on the landscape. Lester soils have a thicker, darker A1 horizon. They have a weak A2 horizon, if one is present. Luther soils have colors of lower chroma in the B horizon and are on nearly level ridgetops.

Typical pedon of Hayden loam, 2 to 5 percent slopes, 1,164 feet west and 2,405 feet north of the SE corner of sec. 30, T. 85 N., R. 26 W.

A1—0 to 2 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; discontinuous black (10YR 2/1) coatings on peds; weak fine angular blocky structure parting to weak very fine granular; friable; neutral; clear smooth boundary.

A21—2 to 5 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on peds; moderate thin platy structure; friable; slightly acid; clear smooth boundary.

A22—5 to 10 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on peds; weak medium platy structure parting to weak fine subangular blocky; friable; discontinuous gray (10YR 6/1) very fine uncoated sand grains on faces of peds; slightly acid; clear smooth boundary.

B1—10 to 14 inches; dark yellowish brown (10YR 4/4) loam; discontinuous dark grayish brown (10YR 4/2) coatings on peds; weak medium angular blocky structure parting to moderate medium subangular blocky; friable; discontinuous gray (10YR 6/1) very fine uncoated sand grains on faces of peds; slightly acid; gradual smooth boundary.

B21t—14 to 21 inches; dark yellowish brown (10YR 4/4) clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure parting to moderate medium angular blocky; firm; discontinuous gray (10YR 6/1) uncoated sand grains on faces of peds; discontinuous moderately thick dark grayish brown (10YR 4/2) clay films on faces of peds and in pores; medium acid; gradual smooth boundary.

B22t—21 to 27 inches; yellowish brown (10YR 5/4) clay loam; few fine distinct red (2.5YR 4/8) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; discontinuous gray (10YR 6/1) uncoated sand grains on faces of peds; discontinuous moderately thick dark yellowish brown (10YR 4/4) clay films on faces of peds and in pores; medium acid; gradual smooth boundary.

B23t—27 to 33 inches; yellowish brown (10YR 5/6) clay loam; few fine prominent yellowish red (5YR 4/8) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; discontinuous moderately thick dark yellowish brown (10YR 3/4) clay films on faces of peds; black (10YR 2/1) organic stains on peds; common manganese concretions; medium acid; clear smooth boundary.

B3t—33 to 42 inches; light olive brown (2.5Y 5/4) loam, weak medium prismatic structure parting to moderate medium subangular blocky; firm; discontinuous thick very dark grayish brown (10YR 3/2) clay films on faces of peds; common iron and manganese concretions; slightly acid; clear smooth boundary.

C1—42 to 48 inches; light olive brown (2.5Y 5/4) loam; few fine prominent strong brown (7.5YR 5/6) mottles; massive; friable; common iron, manganese, and calcium carbonate concretions; slight effervescence; moderately alkaline; gradual smooth boundary.

C2—48 to 60 inches; light olive brown (2.5Y 5/4) loam; massive; friable; common iron, manganese, and calcium carbonate concretions; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 46 inches.

The A1 horizon has color value of 2 or 3 and chroma of 1 or 2. It is loam or silt loam high in sand. The A2 horizon has value of 4 or 5 and chroma of 1 or 2. It ranges from loam to silt loam high in sand. The B2t horizon has value of 4 or 5 and chroma of 3 through 6. It is loam or clay loam. Reaction ranges from slightly acid to strongly acid.

Jacwin series

The Jacwin series consists of somewhat poorly drained soils on concave upland side slopes. The soils are moderately permeable in the upper part and very slowly permeable in the lower part. They formed in glacial till or colluvium derived from glacial till and the underlying material derived from shale. The slope ranges from 3 to 9 percent.

Jacwin soils commonly are adjacent to Moingona and Sattre soils on the landscape. Moingona soils have less clay in the lower B horizon and in the C horizon. Sattre soils have a gravelly or sandy lower B horizon and C horizon.

Typical pedon of Jacwin loam, 3 to 9 percent slopes, 900 feet east and 500 feet north of the SW corner of sec. 13, T. 84 N., R. 27 W.

Ap—0 to 7 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

A12—7 to 13 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry, continuous black (N 2/0) coatings on peds; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

B1t—13 to 20 inches; dark grayish brown (10YR 4/2) sandy clay loam, weak medium subangular blocky structure; friable; discontinuous moderately thick very dark gray (10YR 3/1) clay films on faces of peds; few fine iron concretions; neutral; clear smooth boundary.

B2t—20 to 29 inches; light olive brown (2.5Y 5/4) sandy clay loam; weak medium subangular blocky structure; friable; discontinuous moderately thick grayish brown (2.5Y 5/2) clay films on faces of peds; few fine iron concretions; neutral; abrupt smooth boundary.

IIB3—29 to 33 inches; mottled grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/8) clay; massive; firm; few fine iron and manganese concretions; mildly alkaline; clear smooth boundary.

IICg—33 to 60 inches; mixed dark greenish gray (5GY 4/1), greenish gray (5GY 6/1), brownish yellow (10YR 6/8), dark gray (10YR 4/1), and very dark gray (N 3/0) clayey shale; massive; very firm; carbonates disseminated and segregated in a few soft masses; slight effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 48 inches. Depth to carbonates ranges from 24 to 42 inches. Depth to material derived from shale ranges from 20 to 30 inches. The thickness of the mollic epipedon ranges from 12 to 24 inches.

The A horizon is neutral, or it has hue of 10YR, value of 2, and chroma of 1 or less. The B horizon has hue of 10YR and 2.5Y, value of 4 or 5, and chroma of 2 to 6. It is loam, sandy clay loam or clay loam. Where the B horizon extends into material derived from shale, it is variegated clay or silty clay. Reaction in the upper part of the B horizon is slightly acid or neutral.

Le Sueur series

The Le Sueur series consists of somewhat poorly drained, moderately permeable soils on uplands. These soils formed in loamy glacial till. The slope ranges from 0 to 2 percent.

Le Sueur soils are similar to Lester, Luther, and Nicollet soils and are commonly adjacent to the Lester soils on the landscape. Lester soils have colors of higher chroma directly below the mollic epipedon and typically have steeper slopes. Luther soils do not have a mollic epipedon and have a prominent A2 horizon. Nicollet soils do not have an argillic horizon.

Typical pedon of Le Sueur loam, 0 to 2 percent slopes, 1,550 feet east and 2,610 feet north of the SW corner of sec. 30, T. 84 N., R. 26 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

A12—6 to 8 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; continuous very dark brown (10YR 2/2) coatings on peds; weak fine granular structure; friable; neutral; clear smooth boundary.

B1t—8 to 16 inches; very dark grayish brown (10YR 3/2) clay loam; continuous very dark gray (10YR 3/1) coatings on peds; moderate fine angular blocky structure; firm; discontinuous thin clay films on faces of peds; slightly acid; clear smooth boundary.

B21t—16 to 24 inches; dark grayish brown (2.5Y 4/2) clay loam; discontinuous very dark gray (10YR 3/1) coatings on peds; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine prismatic structure parting to moderate fine angular blocky; firm; discontinuous thin clay films on faces of peds; slightly acid; gradual smooth boundary.

B22t—24 to 34 inches; dark grayish brown (10YR 4/2) clay loam; discontinuous very dark gray (10YR 3/1) coatings on peds; common fine distinct yellowish brown (10YR 5/8) mottles; weak very fine prismatic structure parting to moderate fine angular blocky; firm; discontinuous moderately thick clay films on faces of peds; slightly acid; clear smooth boundary.

B3t—34 to 40 inches; dark grayish brown (2.5Y 4/2) clay loam; common fine prominent strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; firm; discontinuous moderately thick clay films on faces of peds; slightly acid; clear smooth boundary.

C1—40 to 49 inches; grayish brown (2.5Y 5/2) loam; many medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; few fine manganese concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—49 to 60 inches; grayish brown (2.5Y 5/2) loam; common large prominent strong brown (7.5YR 5/6) mottles; massive; friable; few fine manganese concretions; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 50 inches. The mollic epipedon is 10 to 18 inches thick.

The A1 horizon has color value of 2 or 3 and chroma of 1. It ranges from silt loam high in sand to clay loam. The A2 horizon, where present, has weak platy structure, unlike the A1 horizon. The B2t horizon has color hue of 2.5Y or 10YR. Reaction ranges from strongly acid to slightly acid.

Lester series

The Lester series consists of well drained, moderately permeable soils on uplands. These soils formed in glacial till. The slope ranges from 2 to 9 percent.

Lester soils are similar to Clarion, Hayden, and Le Sueur soils and are commonly adjacent to Le Sueur soils on the landscape. Unlike Lester soils, Clarion soils have a mollic epipedon and do not have an argillic horizon. Hayden soils have a thinner A1 horizon and a prominent A2 horizon. Le Sueur soils are nearly level. They have a mollic epipedon, and the color of their Bt horizon is of lower chroma than that of Lester soils.

Typical pedon of Lester loam, 2 to 5 percent slopes, 545 feet west and 500 feet north of the SE corner of sec. 30, T. 83 N., R. 26 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; friable; medium acid; clear smooth boundary.

B1—7 to 13 inches; brown (10YR 4/3) loam, brown (10YR 5/3) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on peds; weak medium subangular blocky structure; friable; medium acid; clear smooth boundary.

B21t—13 to 18 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; firm; continuous moderately thick dark brown (10YR 3/3) clay films on faces of peds; medium acid; gradual smooth boundary.

B22t—18 to 29 inches; dark yellowish brown (10YR 4/4) clay loam; few fine prominent yellowish red (5YR 5/8) and dark reddish brown (5YR 2/2) mottles; moderate medium subangular blocky structure; firm; discontinuous thick dark brown (7.5YR 3/2) clay films on faces of peds; few iron and manganese concretions; medium acid; gradual smooth boundary.

B23t—29 to 32 inches; yellowish brown (10YR 5/4) clay loam; few fine prominent yellowish red (5YR 5/8) and dark reddish brown (5YR 2/2) mottles; moderate medium subangular blocky structure; firm; discontinuous thick dark brown (7.5YR 3/2) clay films on faces of peds; few iron and manganese concretions; slightly acid; clear smooth boundary.

C1—32 to 37 inches; yellowish brown (10YR 5/4) clay loam; few fine prominent yellowish red (5YR 5/8) and dark reddish brown (5YR 2/2) mottles; massive; firm; few iron and manganese concretions; few soft masses of calcium carbonate; strong effervescence; mildly alkaline; gradual boundary.

C2—37 to 44 inches; mottled yellowish brown (10YR 5/4), yellowish red (5YR 5/8), dark reddish brown (5YR 2/2), and strong brown (7.5YR 5/6) loam; massive; friable; few iron and manganese concretions; few soft masses of calcium carbonate; strong effervescence; mildly alkaline; gradual smooth boundary.

C3—44 to 60 inches; mottled light yellowish brown (10YR 6/4), yellowish brown (10YR 5/4), strong brown (7.5YR 5/6), and dark reddish brown (5YR 2/2) loam; massive; friable; few iron and manganese concretions; few soft masses of calcium carbonate; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 48 inches.

The A1 horizon has color value of 2 or 3 and chroma of 1 or 2. It ranges from sandy loam to clay loam. The A2 horizon, where present, has value of 3 or 4 and chroma of 1 or 2. It is sandy loam or loam and in most places is mixed with the Ap horizon. The B2t horizon has value of 4 or 5 and chroma of 3 or 4. Reaction ranges from strongly acid to slightly acid.

Linder series

The Linder series consists of somewhat poorly drained soils on stream benches. Permeability is moderately rapid in the upper part and rapid in the lower part. These soils formed in loamy alluvium that is underlain by sand and gravel at a depth of 24 to 40 inches. The slope ranges from 0 to 2 percent.

Linder soils are similar to and are commonly adjacent to Biscay and Cylinder soils on the landscape. Biscay soils have less sand in the upper part of the solum, a contrasting control section, and colors of lower chroma directly below the mollic epipedon. Cylinder soils have less sand in the upper part of the solum and a contrasting control section.

Typical pedon of Linder sandy loam, 0 to 2 percent slopes, 190 feet north and 317 feet west of the SE corner of sec. 29, T. 84 N., R. 28 W.

Ap—0 to 8 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; black (N 2/0) coatings on peds; moderate fine subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

A12—8 to 15 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; continuous black (N 2/0) coatings on peds; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

A13—15 to 19 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; continuous black (2/1) coatings on peds; moderate medium subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

B1—19 to 23 inches; very dark grayish brown (2.5Y 3/2) sandy loam; moderate medium subangular blocky structure; friable; neutral; clear smooth boundary.

B2—23 to 31 inches; dark grayish brown (2.5Y 4/2) sandy loam; discontinuous very dark grayish brown (2.5Y 3/2) coatings on peds; few medium faint light olive brown (2.5Y 5/4) mottles; moderate fine subangular blocky structure; very friable; very slight effervescence; mildly alkaline; clear smooth boundary.

IIB3—31 to 34 inches; grayish brown (2.5Y 5/2) gravelly loamy sand; discontinuous dark grayish brown (2.5Y 4/2) coatings on peds; weak fine subangular blocky structure parting to single grained; loose; slight effervescence; moderately alkaline; gradual wavy boundary.

IIC1—34 to 43 inches; grayish brown (2.5Y 5/2) gravelly sand; discontinuous olive brown (2.5Y 4/4) coatings on peds; single grained; loose; slight effervescence; moderately alkaline; gradual wavy boundary.

IIC2—43 to 60 inches; grayish brown (2.5Y 5/2) gravelly sand; single grained; loose; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 40 inches. The depth to loamy sand, sand, or gravelly sand ranges from 24 to 36 inches. The depth to free carbonates ranges from 20 to 36 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has color value of 2 or 3 and chroma of 2 or less. It is loam or sandy loam. The B horizon has value of 4 or 5 and chroma of 2. Reaction typically is slightly acid or neutral, but in some pedons it is mildly alkaline in the lower part. The C horizon is sand that has variable amounts of gravel.

Luther series

The Luther series consists of somewhat poorly drained, moderately slowly permeable soils on uplands. The soils formed in glacial till. The slope ranges from 0 to 2 percent.

Luther soils are similar to Hayden, Lester, and Le Sueur soils and are commonly adjacent to Hayden soils on the landscape. Hayden and Lester soils are on convex, more sloping areas and have colors of higher chroma in the subsoil. In places Le Sueur soils do not have an A2 horizon; in other places the A2 horizon is less prominent.

Typical pedon of Luther loam, 0 to 2 percent slopes, 687 feet south and 924 feet west of the center of sec. 8, T. 83 N., R. 26 W.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) loam, gray (10YR 5/1) dry; discontinuous very dark gray (10YR 3/1) coating on peds; moderate fine subangular blocky structure parting to moderate fine granular; friable; many very fine roots; many fine tubular pores; slightly acid; clear smooth boundary.

A21—4 to 7 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; discontinuous very dark gray (10YR 3/1) coatings on peds; moderate fine subangular blocky structure parting to moderate fine granular; friable; many very fine roots; common very fine tubular pores; slightly acid; clear smooth boundary.

A22—7 to 10 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on peds; weak medium platy structure parting to weak fine subangular blocky; very friable; discontinuous gray uncoated silt and sand grains on

faces of peds; common very fine roots; many very fine interstitial pores; slightly acid; clear smooth boundary.

A23—10 to 15 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on peds; moderate fine subangular blocky structure; friable; discontinuous gray uncoated silt and sand grains on faces of peds; common very fine roots; common very fine interstitial and tubular pores; slightly acid; clear smooth boundary.

B1t—15 to 18 inches; dark grayish brown (10YR 4/2) clay loam; moderate medium subangular blocky structure; firm; discontinuous dark grayish brown (10YR 4/2) uncoated silt and sand grains on faces of peds; discontinuous thin very dark grayish brown (10YR 3/2) clay films on peds; common very fine roots; common very fine interstitial and tubular pores; medium acid; clear smooth boundary.

B21t—18 to 22 inches; dark grayish brown (10YR 4/2) clay loam; weak medium prismatic structure parting to moderate medium angular blocky; firm; discontinuous moderately thick very dark grayish brown (10YR 3/2) clay films on peds and pores; few very fine roots; few very fine interstitial and tubular pores; medium acid; clear smooth boundary.

B22t—22 to 28 inches; grayish brown (10YR 5/2) clay loam; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to weak medium angular blocky; firm; discontinuous moderately thick very dark grayish brown (10YR 3/2) clay films on peds and pores; few very fine roots; few very fine tubular pores; few manganese concretions; slightly acid; clear smooth boundary.

B3t—28 to 36 inches; grayish brown (2.5Y 5/2) clay loam; common medium prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to weak medium angular blocky; firm; discontinuous moderately thick dark grayish brown (2.5Y 4/2) pores; few fine roots; few very fine tubular pores; many manganese concretions; neutral; clear smooth boundary.

C1—36 to 40 inches; grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) loam; many medium prominent yellowish brown (10YR 5/8) mottles; massive; friable; moderately thick clay films in pores; few fine roots; few fine tubular pores; many manganese concretions; slight effervescence; moderately alkaline; clear smooth boundary.

C2—40 to 44 inches; mottled grayish brown (2.5Y 5/2), light brownish gray (2.5Y 6/2), and yellowish brown (10YR 5/8) loam; massive; friable; discontinuous moderately thick clay films in pores; few very fine tubular pores; few manganese concretions; slight effervescence; moderately alkaline; abrupt smooth boundary.

C3—44 to 52 inches; grayish brown (2.5Y 5/2) loam; many medium prominent yellowish brown (10YR 5/8) mottles; massive; friable; few very fine tubular pores; slight effervescence; moderately alkaline; abrupt smooth boundary.

C4—52 to 60 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/8) loam; massive; friable; few very fine interstitial and tubular pores; slight effervescence; moderately alkaline.

The thickness of the solum and depth to free carbonates range from 36 to 60 inches.

The A1 horizon has color value of 3 or 4 and chroma of 1 or 2. The A2 horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 1 or 2. It ranges from loam to very fine sandy loam. The B2t horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 2 or 3. Mottles are few to many. Reaction is strongly acid to slightly acid.

Marna series

The Marna series consists of poorly drained, slowly permeable soils on uplands. The soils formed in loamy and clayey sediment and the underlying glacial till. The slope ranges from 0 to 2 percent.

Marna soils are similar to Guckeen and Webster soils and are commonly adjacent to the Guckeen soils on the landscape. Guckeen soils do not have distinct or prominent mottles directly below the mollic epipedon and are typically in higher positions on the landscape. Webster soils have less clay throughout and have a fine-loamy control section.

Typical pedon of Marna silty clay loam, 0 to 2 percent slopes, 48 feet east and 186 feet south of the NW corner of sec. 5, T. 85 N., R. 28 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate fine subangular blocky structure; firm; neutral; clear smooth boundary.

A12—8 to 16 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate fine subangular blocky structure; very firm; neutral; gradual smooth boundary.

A3—16 to 22 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (N 4/0) dry, discontinuous black (10YR 2/1) coatings on peds; moderate fine subangular blocky structure; very firm; neutral; clear smooth boundary.

B21g—22 to 26 inches; dark gray (5Y 4/1) silty clay, discontinuous very dark gray (N 3/0) coatings in pores; moderate medium subangular blocky structure parting to moderate fine subangular blocky; very firm; neutral; gradual smooth boundary.

B22g—26 to 32 inches; olive gray (5Y 5/2) silty clay, discontinuous very dark gray (N 3/0) coatings along pores; weak very fine prismatic structure parting to moderate medium subangular blocky; very firm; few iron concretions; neutral; gradual smooth boundary.

B23—32 to 40 inches; olive gray (5Y 5/2) silty clay loam; common fine distinct yellowish brown (10YR 5/6) and many fine faint olive (5Y 5/6) mottles; weak very fine prismatic structure parting to moderate medium subangular blocky; very firm; few iron concretions; neutral; gradual smooth boundary.

B24g—40 to 46 inches; olive gray (5Y 5/2) and olive (5Y 5/3) silty clay loam; common fine prominent yellowish brown (10YR 5/8) and common fine faint olive (5Y 5/4) mottles; moderate medium subangular blocky structure; firm; few iron concretions; neutral; clear smooth boundary.

IIC1g—46 to 54 inches; olive gray (5Y 5/2) clay loam; common medium prominent yellowish brown (10YR 5/8) and many fine faint olive (5Y 5/6) mottles; massive; friable; few soft masses of calcium carbonate; very slight effervescence; mildly alkaline; clear smooth boundary.

IIC2g—54 to 60 inches; mottled olive gray (5Y 5/2) olive (5Y 5/4), and yellowish brown (10YR 5/6) clay loam; massive; friable; few soft masses of calcium carbonate; slight effervescence; mildly alkaline.

The thickness of the solum and depth to free carbonates range from 30 to 48 inches. The depth to the underlying glacial till ranges from 30 to 40 inches or more. The thickness of the mollic epipedon ranges from 16 to 24 inches.

The A horizon is neutral, or it has hue of 10YR, value of 2, and chroma of 1 or less. It is silty clay loam or silty clay. The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. Where chroma is 2, the B horizon has distinct or prominent mottles. The upper part of the B horizon is silty clay or clay. Reaction is slightly acid or neutral. The IIC horizon is loam or clay loam.

Moingona series

The Moingona series consists of moderately well drained, moderately permeable soils on alluvial fans and foot slopes along major streams. The soils formed in loamy alluvium. The slope ranges from 1 to 14 percent.

Moingona soils are similar to Le Sueur and Terril soils and are commonly adjacent to Hayden and Sattre soils on the landscape. Terril soils do not have an argillic horizon. Hayden and Le Sueur soils formed in glacial till and have more stones and pebbles. Sattre soils are underlain by sand and gravel.

Typical pedon of Moingona loam, 5 to 9 percent slopes, 850 feet east and 500 feet south of the center of sec. 11, T. 85 N., R. 27 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; moderate fine subangular blocky structure parting to weak medium granular; friable; common micro and very fine random roots; many micro and very fine tubular and vesicular pores; medium acid; clear smooth boundary.

A12—7 to 12 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; friable; few micro and very fine random roots; many micro and very fine tubular and vesicular pores; slightly acid; clear smooth boundary.

B1t—12 to 16 inches; brown (10YR 4/3) loam; moderate medium subangular blocky structure; friable; few micro and very fine random roots; many micro and very fine tubular and vesicular pores; discontinuous thin clay films on faces of peds; gray (10YR 6/1) uncoated fine sand and silt on faces of peds; slightly acid; clear smooth boundary.

B21t—16 to 20 inches; brown (10YR 4/3) clay loam; moderate medium subangular blocky structure; friable; very few micro random roots; many micro and very fine tubular, irregular, and vesicular pores; discontinuous thin clay films on faces of peds, in pores, and as bridges of sand grains; slightly acid; gradual smooth boundary.

B22t—20 to 27 inches; brown (10YR 4/3) clay loam; moderate medium angular blocky structure; friable; very few micro random roots; many micro and very fine tubular and vesicular pores; discontinuous moderately thick clay films on faces of peds and in pores; neutral; gradual smooth boundary.

B23t—27 to 34 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; friable; many micro and very fine to fine tubular, irregular, and vesicular pores; discontinuous moderately thick clay films on faces of peds, in pores, and as bridges of sand grains; neutral; gradual smooth boundary.

B3t—34 to 40 inches; brown (10YR 4/3) clay loam; weak medium subangular blocky structure; friable; many micro to fine tubular, irregular, and vesicular pores; discontinuous thin clay films on faces of peds, in pores, and as bridges of sand grains; neutral; gradual smooth boundary.

C1—40 to 48 inches; brown (10YR 4/3) loam; few fine prominent strong brown (7.5YR 5/6) mottles; massive; friable; many micro to fine tubular, irregular, and vesicular pores; discontinuous thin clay films in pores and as bridges of sand grains; slight effervescence; moderately alkaline; clear smooth boundary.

C2—48 to 60 inches; olive brown (2.5Y 4/4) loam; few fine distinct strong brown (7.5YR 5/6) mottles; massive; friable; many micro and very fine tubular, interstitial, and vesicular pores; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 60 inches. The thickness of the mollic epipedon ranges from 10 to 17 inches.

The A1 horizon has color value of 2 or 3 and chroma of 1 or 2. The A2 horizon, where present, has value of 3 or 4. The A horizon is loam or sandy loam. The Bt

horizon has chroma of 4 or 5. The clay content ranges from 21 to 35 percent. The C horizon ranges from sandy loam to clay loam.

Nicollet series

The Nicollet series consists of somewhat poorly drained, moderately permeable soils on uplands. The soils formed in loamy glacial till. The slope ranges from 1 to 3 percent.

Nicollet soils are commonly adjacent to Canisteo, Clarion, and Webster soils on the landscape. Canisteo and Webster soils have colors of lower chroma in the subsoil. Clarion soils have colors of higher chroma in the subsoil.

Typical pedon of Nicollet loam, 1 to 3 percent slopes, 153 feet east and 1,155 feet north of the SW corner of sec. 3, T. 82 N., R. 27 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure parting to moderate medium granular; friable; slightly acid; clear smooth boundary.

A12—8 to 11 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; continuous black (10YR 2/1) coatings on peds; moderate medium subangular blocky structure parting to moderate fine subangular blocky; friable; slightly acid; clear smooth boundary.

A13—11 to 17 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; discontinuous very dark gray (10YR 3/1) coatings on peds; moderate medium subangular blocky structure parting to moderate fine subangular blocky; friable; neutral; clear smooth boundary.

B1—17 to 25 inches; dark grayish brown (10YR 4/2) loam; discontinuous very dark grayish brown (10YR 3/2) coatings on peds; few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure parting to moderate fine subangular blocky; friable; neutral; clear smooth boundary.

B2—25 to 34 inches; dark grayish brown (10YR 4/2) loam; common fine prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; few iron and manganese concretions; neutral; gradual smooth boundary.

B3—34 to 37 inches; grayish brown (2.5Y 5/2) loam; common medium prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; few iron and manganese concretions; mildly alkaline; clear smooth boundary.

C1—37 to 45 inches; grayish brown (2.5Y 5/2) loam; few fine prominent red (2.5YR 4/6) and many medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; few iron, manganese, and carbonate concretions; slight effervescence; moderately alkaline; gradual smooth boundary.

C2—45 to 55 inches; olive gray (5Y 5/2) loam; few medium prominent red (2.5YR 4/6) and common medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; few iron, manganese, and carbonate concretions; slight effervescence; moderately alkaline; gradual smooth boundary.

C3—55 to 60 inches; olive gray (5Y 5/2) loam; common medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; few iron, manganese, and carbonate concretions; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 48 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. It ranges from loam to clay loam or silt loam high in sand. The B2 horizon has hue of 10YR or 2.5Y. It is loam or clay loam. Reaction is slightly acid or neutral. The lower part of the B horizon is mildly alkaline in places.

Okoboji series

The Okoboji series consists of very poorly drained, moderately slowly permeable soils in depressions on uplands. The soils formed in local sediment derived from glacial till. Slope ranges from 0 to 1 percent.

Okoboji soils are similar to Blue Earth and Palms soils and are commonly adjacent to Canisteo, Harps, and Webster soils on the landscape. Blue Earth and Palms soils have a histic epipedon. Canisteo, Harps, and Webster soils have more sand and less clay in the control section and have a thinner mollic epipedon.

Typical pedon of Okoboji mucky silt loam, 0 to 1 percent slopes, 1,080 feet west and 960 feet north of the SE corner of sec. 22, T. 83 N., R. 25 W.

A11—0 to 4 inches; black (10YR 2/1) mucky silt loam, very dark gray (10YR 3/1) dry; black (N 2/0) coatings on peds; moderate fine angular blocky structure parting to moderate fine and very fine granular; friable; about 15 percent organic matter; neutral; clear wavy boundary.

A12—4 to 9 inches; black (10YR 2/1) mucky silt loam, very dark gray (10YR 3/1) dry; black (N 2/0) coatings on peds; moderate medium subangular blocky structure parting to moderate very fine granular; friable; about 14 percent organic matter; neutral; clear wavy boundary.

A13—9 to 14 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; black (N 2/0) coatings on peds; moderate fine angular blocky structure; firm; about 7 percent organic matter; neutral; gradual wavy boundary.

A14—14 to 19 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; black (N 2/0) coatings on peds; few fine prominent dark reddish brown (5YR

3/4) mottles; moderate medium angular blocky structure; firm; neutral; gradual wavy boundary.

A15—19 to 24 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; black (N 2/0) coatings on peds; common fine prominent dark reddish brown (5YR 3/4) mottles; weak medium subangular blocky structure; firm; mildly alkaline; clear wavy boundary.

B1g—24 to 27 inches; gray (5Y 5/1) and light olive gray (5Y 6/2) silty clay loam; very dark gray (5Y 3/1) coatings on peds; common fine prominent dark yellowish brown (10YR 4/4) and few fine prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

B21g—27 to 37 inches; light gray (5Y 7/1) silty clay loam, gray (5Y 6/1) coatings on peds; common fine distinct pale olive (5Y 6/4) and common fine prominent reddish brown (5YR 4/4) mottles; weak medium subangular blocky structure; friable; slight effervescence; moderately alkaline; clear wavy boundary.

B22—37 to 42 inches; mottled yellowish brown (10YR 5/6) and olive (5Y 5/3) silty clay loam; weak medium subangular blocky structure; friable; slight effervescence; moderately alkaline; clear wavy boundary.

C1G—42 to 57 inches; mottled dark bluish gray (5B 4/1), olive gray (5Y 5/2), olive (5Y 5/3), and yellowish brown (10YR 5/6) silty clay loam; massive; friable; slight effervescence; moderately alkaline; clear wavy boundary.

IICg—57 to 60 inches; olive gray (5Y 5/2) and olive (5Y 5/3) sand; single grained; loose; moderately alkaline.

The thickness of the solum ranges from 40 to 60 inches. The depth to free carbonates ranges from 20 to 50 inches. The thickness of the mollic epipedon ranges from 24 to 36 inches.

The A horizon ranges from mucky silt loam to silty clay loam. The B2g horizon has color hue of 2.5Y or 5Y, value of 4 to 7, and chroma of 1 to 3. It is heavy silty clay loam or silty clay. It ranges from neutral to moderately alkaline. The C horizon is silt loam or silty clay loam. Sand lenses are present in places in the lower part.

Palms series

The Palms series consists of very poorly drained soils on upland basins that were formerly lakes or ponds. These soils formed in highly decomposed organic material and the underlying sediment. Permeability is moderately rapid in the organic material and moderate in the underlying sediment. The slope ranges from 0 to 1 percent.

Palms soils are similar to Blue Earth and Okoboji soils. Blue Earth soils have a calcareous histic epipedon less than 20 inches thick.

Typical pedon of Palms muck, 0 to 1 percent slopes, 390 feet east and 2,300 feet north of the SW corner of sec. 6, T. 85 N., R. 25 W.

Oa1—0 to 7 inches; black (N 2/0) broken face and rubbed sapric material, very dark gray (10YR 3/1) dry; less than 10 percent fiber; less than 1 percent rubbed; moderate medium granular structure; very friable; slightly acid; clear smooth boundary.

Oa2—7 to 15 inches; black (N 2/0) broken face and rubbed sapric material, black (10YR 2/1) dry; about 12 percent fiber; less than 5 percent rubbed; moderate medium granular structure; very friable; slightly acid; gradual smooth boundary.

Oa3— 15 to 23 inches; black (N 2/0) broken face and rubbed sapric material, very dark gray (10YRE 3/1) dry; less than 10 percent fiber, less than 1 percent rubbed; moderate medium granular structure; very friable; slightly acid; clear smooth boundary.

Oa4—23 to 27 inches; black (N 2/0) broken face and rubbed sapric material, dark gray (10YR 4/1) dry; less than 10 percent fiber; less than 1 percent rubbed; moderate fine subangular blocky structure; very friable; strong effervescence; segregated lime; mildly alkaline; clear smooth boundary.

Oa5—27 to 36 inches; black (10YR 2/1) broken face and rubbed sapric material, gray (10YR 5/1) dry; less than 10 percent fiber; less than 1 percent rubbed; few fine distinct gray (10YR 6/1) mottles; weak fine subangular blocky structure; very friable; strong effervescence; segregated lime and snail shells; moderately alkaline; clear smooth boundary.

IIA11b—36 to 51 inches; black (N 2/0) silt loam; massive; friable; strong effervescence; segregated lime; moderately alkaline; clear smooth boundary.

IIA12b—51 to 56 inches; black (N 2/0) silt loam; massive; friable; strong effervescence; segregated lime; moderately alkaline; abrupt smooth boundary.

IICg—56 to 63 inches; gray (5Y 6/1 and 5/1) silt loam; massive; friable; strong effervescence; moderately alkaline.

The thickness of the sapric material ranges from 20 to 48 inches. The depth to carbonates ranges from 20 to 40 inches.

The Oa horizon has color hue of 10YR, or it is neutral and has value of 2 and chroma of 2 or less. The IIA1b horizon, where present, ranges from fine sandy loam to silty clay loam. The IICg horizon ranges from sandy loam to clay loam.

Ridgeport series

The Ridgeport series consists of somewhat excessively drained soils on stream terraces.

Permeability is moderately rapid in the upper part and rapid in the lower part. These soils formed in loamy and sandy alluvium. The slope ranges from 0 to 9 percent.

Ridgeport soils are similar to Wadena and Zenor soils and are commonly adjacent to Wadena soils on the landscape. Ridgeport soils have less clay in the control section than Wadena and Zenor soils.

Typical pedon of Ridgeport sandy loam, 0 to 2 percent slopes, 117 feet north and 1,250 feet west of the SE corner of sec. 26, T. 85 N., R. 25 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; discontinuous black (10YR 2/1) coatings on peds; moderate medium subangular blocky structure parting to moderate medium granular; friable; slightly acid; clear smooth boundary.

A12—8 to 14 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; discontinuous very dark brown (10YR 2/2) coatings on peds; moderate medium subangular blocky structure parting to moderate medium granular; friable; slightly acid; clear smooth boundary.

B1—14 to 21 inches; dark yellowish brown (10YR 4/4) sandy loam; discontinuous dark yellowish brown (10YR 3/4) coatings on peds; weak medium subangular blocky structure parting to moderate medium fine granular; very friable; slightly acid; clear smooth boundary.

B21—21 to 25 inches; dark yellowish brown (10YR 4/4) sandy loam; weak medium subangular blocky structure parting to weak fine granular; very friable; neutral; gradual smooth boundary.

B22—25 to 32 inches; brown (7.5YR 4/4) sandy loam; weak medium subangular blocky structure parting to weak fine granular; very friable; neutral; clear smooth boundary.

IIB3—32 to 37 inches; dark yellowish brown (10YR 4/4) loamy sand; weak fine granular structure; loose; neutral; clear smooth boundary.

IIC1—37 to 46 inches; variegated sand; single grained; loose; very slight effervescence; mildly alkaline; clear smooth boundary.

IIC2—46 to 60 inches; variegated sand; single grained; loose; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to sand and gravel range from 24 to 40 inches. The thickness of the mollic epipedon ranges from 8 to 18 inches.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. The B2 horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 3 or 4. Reaction is neutral or slightly acid. The IIC horizon is sand or gravelly coarse sand.

Salida series

The Salida series consists of excessively drained, very rapidly permeable soils on uplands and terrace escarpments. The soils formed in sandy and gravelly glacial outwash and alluvial material. The slope ranges from 5 to 25 percent. These soils contain less gravel in the control section than the limits defined for the series. However, this difference does not significantly affect the use and management of the soils.

Salida soils are commonly adjacent to Clarion, Ridgeport, Sattre, Storden, and Zenor soils on the landscape. Clarion soils have a thicker mollic epipedon and a fine-loamy control section. Ridgeport soils are deeper to carbonates and have a coarse-loamy control section.

Typical pedon of Salida gravelly sandy loam, 5 to 14 percent slopes, 2,590 feet west and 164 feet south of the NE corner of sec 1, T. 85 N., R. 26 W.

Ap—0 to 8 inches; dark brown (10YR 3/3) gravelly sandy loam, brown (10YR 4/3) dry; continuous very dark grayish brown (10YR 3/2) coatings on peds; cloddy parting to weak fine granular structure; very friable; mildly alkaline; clear smooth boundary.

B2—8 to 13 inches; brown (10YR 4/3) gravelly loamy sand; weak fine subangular blocky structure parting to weak fine granular; very friable; mildly alkaline; clear wavy boundary.

C1—13 to 39 inches; yellowish brown (10YR 5/4 and 5/6) gravelly loamy sand; single grained; loose; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—39 to 60 inches; variegated brown (10YR 5/3), yellowish brown (10YR 5/4 and 5/6), and very pale brown (10YR 7/4) gravelly loamy sand; single grained; loose; thin silt strata at 50 inches; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 7 to 16 inches. The depth to free carbonates ranges from the surface to 16 inches. The thickness of the mollic epipedon ranges from 7 to 10 inches. The content of gravel is 15 to 35 percent in the control section.

The A horizon has color value of 2 or 3 and chroma of 2 or 3. It ranges from gravelly sandy loam to gravelly loamy coarse sand. The B2 horizon has value of 3 or 4 and chroma of 3 or 4. It ranges from loamy sand to gravelly coarse sand. The C horizon ranges from loamy sand to gravelly coarse sand.

Sattre series

The Sattre series consists of well drained soils on stream benches. Permeability is moderate in the upper part and very rapid in the lower part. These soils formed in loamy alluvium that is underlain by sand and gravel at a depth of 24 to 40 inches. The slope ranges from 0 to 9 percent.

Sattre soils are similar to Lester, Moingona, and Wadena soils and are commonly adjacent to Moingona and Wadena soils on the landscape. Sattre soils have a coarser textured substratum than Lester or Moingona soils. Wadena soils do not have an A2 horizon.

Typical pedon of Sattre loam, 0 to 2 percent slopes, 750 feet west and 550 feet south of the center of sec. 11, T. 85 N., R. 27 W.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure parting to moderate fine granular; friable; slightly acid; clear smooth boundary.

A12—7 to 9 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure parting to moderate fine granular; friable; many micro and very fine random roots; many micro and fine tubular pores; slightly acid; abrupt smooth boundary.

A2—9 to 15 inches; brown (10YR 5/3) loam; continuous light gray (10YR 7/2) dry uncoated silt grains on faces of peds; common medium prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure parting to weak medium platy; friable; common micro and very fine random roots; many micro and very fine tubular and vesicular pores; neutral; clear smooth boundary.

B1t—15 to 22 inches; brown (10YR 4/3) loam; continuous pale brown (10YR 6/3) dry uncoated silt grains on faces of peds; moderate medium to fine angular blocky structure; friable; discontinuous thin clay films on faces of peds and in pores; few micro and very fine random roots; common micro and very fine tubular pores; slightly acid; clear smooth boundary.

B21t—22 to 28 inches; brown (10YR 4/3) loam; moderate medium to fine angular blocky structure; friable; discontinuous moderately thick clay films on faces of peds and in pores; very few micro random roots; common micro and very fine tubular and irregular pores; medium acid; clear smooth boundary.

B22t—28 to 35 inches; brown (10YR 4/3) heavy loam; few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium angular blocky structure; friable discontinuous moderately thick coatings on peds and in pores with bridging of mineral grains; common micro and very fine tubular and irregular pores; strongly acid; abrupt smooth boundary.

IIB23t—35 to 43 inches; dark yellowish brown (10YR 4/4) loamy sand; weak medium subangular blocky structure; very friable; discontinuous moderately thick clay bridges holding mineral grains together; common micro and very fine irregular pores; strongly acid; clear smooth boundary.

IIC1—43 to 49 inches; yellowish brown (10YR 5/4) sand; single grained; loose; strongly acid; gradual smooth boundary.

IIC2—49 to 60 inches; yellowish brown (10YR 5/4) sand; single grained; loose sand; medium acid.

The thickness of the solum ranges from 23 to 43 inches. The solum and the IIC horizon do not have carbonates. The thickness of a surface layer that has mollic colors ranges from 6 to 9 inches.

The Ap and A12 horizons have color value of 2 or 3 and chroma of 1 or 2. They are silt loam or loam. The A2 horizon, where present, has value of 4 or 5 and chroma of 2 or 3. It is silt loam or loam. The B2 horizon has hue of 10YR or 7.5YR and chroma of 3 or 4. It is loam or clay loam. Reaction ranges from slightly to strongly acid. The IIC horizon ranges from fine sand to gravelly coarse sand.

Spillville series

The Spillville series consists of somewhat poorly drained and moderately well drained, moderately permeable soils on bottom lands. The soils formed in loamy alluvium. The slope ranges from 0 to 5 percent.

Spillville soils are similar to Terril soils and are commonly adjacent to Coland soils on the landscape. Coland soils have more clay and less sand. Terril soils have a thinner A horizon.

Typical pedon of Spillville loam, 0 to 2 percent slopes, 460 feet north and 880 feet east of the SW corner of sec. 14, T. 85 N., R 27 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

A12—9 to 17 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; continuous black (10YR 2/1) coatings on peds; moderate fine subangular blocky structure parting to weak fine granular; friable; neutral; diffuse smooth boundary.

A13—17 to 27 inches; very dark brown (10YR 2/2) loam, dark gray (10YR 4/1) dry; continuous black (10YR 2/1) coatings on peds; weak very fine subangular blocky structure parting to moderate fine granular; friable; neutral; diffuse smooth boundary.

A14—27 to 39 inches; very dark brown (10YR 2/2) loam, dark gray (10YR 4/1) dry; continuous very dark gray (10YR 3/1) coatings on peds; weak fine subangular blocky structure parting to moderate fine granular; friable; neutral; gradual smooth boundary.

A15—39 to 52 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; discontinuous very dark gray (10YR 3/1) coatings on peds; weak fine subangular blocky structure parting to moderate fine granular; friable; neutral; gradual smooth boundary.

C—52 to 60 inches; dark brown (10YR 3/3) loam; discontinuous very dark grayish brown (10YR 3/2) coatings on peds; massive; friable; neutral.

The thickness of the solum ranges from 36 to 56 inches; The thickness of the mollic epipedon ranges from 30 to 50 inches.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. Below a depth of 36 inches, it ranges from loam to sandy loam. Reaction is neutral or slightly acid.

Storden series

The Storden series consists of well drained, moderately permeable calcareous soils on uplands. The soils formed in loamy glacial till. The slope ranges from 5 to 50 percent.

Storden soils are commonly adjacent to Clarion, Hayden, Salida, and Zenor soils on the landscape. Clarion soils have a mollic epipedon. Hayden soils have an argillic horizon. Salida and Zenor soils have a coarse-loamy control section.

Typical pedon of Storden loam, 9 to 14 percent slopes, moderately eroded, 480 feet west and 2,140 feet north of the SE corner of sec. 35, T. 85 N., R. 26 W.

Ap—0 to 6 inches; brown (10YR 4/3) loam, brown (10YR 5/3) dry; discontinuous dark grayish brown (10YR 4/2) coatings on peds; weak fine subangular blocky structure; friable; very slight effervescence; moderately alkaline; abrupt smooth boundary.

C1—6 to 25 inches; yellowish brown (10YR 5/6) loam; few fine prominent strong brown (7.5YR 5/8) mottles; massive; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—25 to 39 inches; yellowish brown (10YR 5/6) loam; few fine faint strong brown (7.5YR 5/6) and few fine distinct olive (5Y 5/3) mottles; massive; friable; many manganese concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

C3—39 to 60 inches; light olive brown (2.5Y 5/4) loam; common coarse prominent yellowish brown (10YR 5/8) and strong brown (7.5YR 5/8) mottles; massive; friable; many manganese concretions; strong effervescence; moderately alkaline.

The solum is 4 to 10 inches thick. Free carbonates are in all horizons.

The A horizon has color value of 4 or 5 and chroma of 2 or 3. The C horizon has value of 5 or 6 and chroma of 2 through 6.

Talcot series

The Talcot series consists of poorly drained, calcareous soils on stream benches. Permeability is moderate in the solum and rapid in the substratum. These soils formed in loamy alluvium underlain by sand and gravel at a depth of 32 to 40 inches. The slope ranges from 0 to 2 percent.

Talcot soils are similar to Biscay, Canisteo, and Harcot soils and are commonly adjacent to Biscay and Harcot soils on the landscape. Biscay soils have a neutral or slightly acid solum. Canisteo soils have a loam or clay loam C horizon. Harcot soils have a calcic horizon.

Typical pedon of Talcot clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, 180 feet south and 1,890 feet west of the NE corner of sec. 28, T. 84 N., R. 28 W.

Ap—0 to 7 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; cloddy parting to moderate fine granular structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

A12—7 to 15 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure parting to moderate medium granular; friable; slight effervescence; mildly alkaline; gradual smooth boundary.

A3—15 to 23 inches; black (5Y 2/1) clay loam, very dark gray (5Y 3/1) dry; few narrow tongues of black (N 2/0); weak medium subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

B2g—23 to 30 inches; dark gray (5Y 4/1) and olive gray (5Y 4/2) clay loam; discontinuous very dark gray (5Y 3/1) coatings on peds; few narrow tongues of very dark gray (5Y 3/1); few fine prominent strong brown (7.5YR 5/8) and few fine distinct light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure parting to moderate fine subangular blocky; firm; slight effervescence; moderately alkaline; clear smooth boundary.

B3g—30 to 38 inches; olive gray (5Y 4/2 and 5/2) gravelly sandy clay loam; few narrow tongues of very dark gray (5Y 3/1), few fine prominent strong brown (7.5YR 5/8) and few medium distinct olive (5Y 4/6) mottles; weak medium subangular blocky structure parting to moderate medium granular; very friable; strong effervescence; moderately alkaline; clear smooth boundary.

IICg—38 to 60 inches; variegated olive gray (5Y 5/2), light olive gray (5Y 6/2), and pale olive (5Y 6/3) coarse sand and fine gravel; single grained; loose; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to the IIC horizon range from 32 to 40 inches. The mollic epipedon is 14 to 24 inches thick.

The A horizon is neutral, or it has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3, and chroma of 1 or less. It is clay loam or silty clay loam. The B2g horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam or silty clay loam. Reaction is mildly or moderately alkaline.

Terril series

The Terril series consists of moderately well drained, moderately permeable soils on upland foot slopes. These soils formed in loamy alluvium. The slope ranges from 5 to 9 percent.

Terril soils are commonly adjacent to Moingona and Spillville soils on the landscape. Moingona soils have a thinner mollic epipedon and an argillic horizon. Spillville soils have a thicker mollic epipedon and colors of lower chroma in the subsoil.

Typical pedon of Terril loam, 5 to 9 percent slopes, 99 feet west and 1,050 feet south of the NE corner of sec. 2, T. 84 N., R. 25 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) loam, dark gray (10YR 4/1) dry; continuous black (10YR 2/1) coatings on peds; weak fine angular blocky structure parting to moderate fine granular; friable; neutral; clear wavy boundary.

A12—8 to 15 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; continuous black (10YR 2/1) coatings on peds; weak medium angular blocky structure parting to moderate fine granular; friable; neutral; clear smooth boundary.

A13—15 to 22 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; continuous black (10YR 2/1) coatings on peds; weak fine angular blocky structure parting to moderate fine granular; friable; neutral; gradual smooth boundary.

A14—22 to 28 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; continuous very dark brown (10YR 2/2) coatings on peds; weak medium subangular blocky structure parting to moderate medium to fine granular; friable; neutral; gradual wavy boundary.

B1—28 to 36 inches; dark brown (10YR 3/3) loam; continuous very dark grayish brown (10YR 3/2) coatings on peds; moderate medium angular blocky structure; friable; slightly acid; clear smooth boundary.

B21—36 to 44 inches; brown (10YR 4/3) loam; continuous dark brown (10YR 3/3) coatings on peds; moderate medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

B22—44 to 52 inches; brown (10YR 4/3) loam; continuous dark brown (10YR 3/3) coatings on peds; weak medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

B3—52 to 61 inches; dark yellowish brown (10YR 4/4) loam; continuous dark yellowish brown (10YR 3/4) coatings on peds; few fine prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; slightly acid.

The solum is 36 to 60 inches thick. The depth to free carbonates is more than 50 inches. The mollic epipedon is 24 to 36 inches thick.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. The B2 horizon has value of 3 or 4 and chroma of 3. It is loam or light clay loam. Reaction is slightly acid or neutral.

Wadena series

The Wadena series consists of well drained soils on stream benches. Permeability is moderately rapid in the upper part and rapid in the lower part. These soils formed in loamy alluvium underlain by sand and gravel at a depth of 32 to 40 inches. The slope ranges from 0 to 5 percent. These soils do not have the abrupt to gradual textural change between the B horizon and the IIC horizon that is definitive for the Wadena series. However, this difference does not significantly affect the use or management of the soils.

Wadena soils are similar to Clarion, Ridgeport, and Sattre soils. Clarion soils have less sand in the lower part of the solum, have a fine-loamy control section, and formed in glacial till. Ridgeport soils have more sand in the upper part of the solum and have a coarse-loamy control section. Sattre soils have a thinner A1 horizon and an argillic horizon.

Typical pedon of Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes, 216 feet west and 2,580 feet south of the NE corner of sec. 29, T. 82 N., R. 27 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; continuous black (10YR 2/1) coatings on peds; moderate medium subangular blocky structure parting to moderate fine subangular; friable; slightly acid; clear smooth boundary.

A12—7 to 14 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; discontinuous black (10YR 2/1) coatings on peds; moderate medium subangular blocky structure parting to moderate fine subangular blocky; friable; slightly acid; gradual smooth boundary.

A3—14 to 20 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; discontinuous very dark brown (10YR 2/2) coatings on peds; weak medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21—20 to 30 inches; brown (10YR 4/3) loam; discontinuous dark brown (10YR 3/3) coatings on peds; weak medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

B22—30 to 35 inches; brown (7.5YR 4/4) sandy loam; weak medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

B3—35 to 38 inches; brown (7.5YR 4/4) sandy loam; weak fine subangular blocky structure; very friable; neutral; abrupt smooth boundary.

IIC—38 to 60 inches; variegated coarse sand; single grained; loose; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 40 inches. The depth to sand and gravel ranges from 32 to 40 inches. The thickness of the mollic epipedon ranges from 12 to 20 inches.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The B horizon has value of 3 through 5 and chroma of 3 or 4. It is dominantly loam but grades to sandy loam. Reaction is slightly acid or neutral. The C horizon is sand that has a variable amount of gravel.

Webster series

The Webster series consists of poorly drained, moderately permeable soils on uplands. These soils formed in loamy glacial till and glacial sediments. The slope ranges from 0 to 2 percent.

Webster soils are similar to Canisteo, Coland, and Nicollet soils and are commonly adjacent to Canisteo and Nicollet soils on the landscape. Canisteo soils have free carbonates within 10 inches of the surface. Coland soils have a mollic epipedon more than 24 inches thick. Nicollet soils have colors of higher chroma in the subsoil.

Typical pedon of Webster silty clay loam, 0 to 2 percent slopes, 530 feet east and 250 feet south of the NW corner of sec. 15, T. 83 N., R. 25 W.

Ap—0 to 7 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; cloddy parting to weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

A12—7 to 12 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; neutral; gradual smooth boundary.

A13—12 to 18 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; discontinuous black (10YR 2/1) coatings on peds; weak fine subangular blocky structure parting to moderate fine granular; friable; neutral; gradual smooth boundary.

B1—18 to 22 inches; very dark gray (10YR 3/1) silty clay loam; few fine faint dark grayish brown (2.5Y 4/2) mottles; moderate medium subangular blocky structure parting to weak medium granular; friable; neutral; gradual smooth boundary.

B21g—22 to 26 inches; olive gray (5Y 4/2) clay loam; discontinuous black (10YR 2/1) and very dark gray (10YR 3/1) coatings on peds; few fine faint olive gray (5Y 5/2) mottles; moderate medium subangular blocky structure; friable; moderately thick discontinuous organic stains on faces of peds and in pores; neutral; clear smooth boundary.

B22g—26 to 30 inches; olive gray (5Y 5/2) loam; discontinuous black (10YR 2/1) and very dark gray (10YR 3/1) coatings on peds; few fine faint olive (5Y 5/3) mottles; weak medium subangular blocky structure parting to weak fine subangular blocky; friable; moderately thick discontinuous organic stains on faces of peds and in pores; few iron and manganese concretions; neutral; clear smooth boundary.

B3g—30 to 33 inches; olive (5Y 5/3) loam; discontinuous black (10YR 2/1) and very dark gray (10YR 3/1) coatings on peds; few fine prominent yellowish brown (10YR 5/8) and few medium distinct pale olive (5Y 6/4) mottles; weak medium subangular blocky structure; friable; moderately thick discontinuous organic stains on faces of peds and in pores; few iron and manganese concretions; few soft lime masses; mildly alkaline; abrupt smooth boundary.

C1g—33 to 42 inches; light olive gray (5YR 6/2) loam; few medium prominent yellowish brown (10YR 5/8) and few medium distinct olive gray (5Y 4/2) mottles; massive; friable; few iron and manganese concretions; soft lime masses; slight effervescence; mildly alkaline; gradual smooth boundary.

C2g—42 to 60 inches; mottled light olive gray (5Y 6/2), olive (5Y 5/3), dark gray (5Y 4/1), and yellowish brown (10YR 5/8) loam; massive; friable; few iron and manganese concretions; soft lime masses; violent effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 24 to 48 inches. The mollic epipedon is 14 to 24 inches thick.

The A horizon is neutral, or it has hue of 10YR, value of 2, and chroma of 1 or less. It is clay loam or silty clay loam high in sand. The B2 horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 to 3. It is clay loam or silty clay loam high in sand. Reaction is neutral or mildly alkaline.

Zenor series

The Zenor series consists of somewhat excessively drained soils on knobby outwash areas on uplands. Permeability is moderately rapid in the subsoil and rapid in the substratum. These soils formed in material that is dominantly sandy loam over loamy sand. The slope ranges from 2 to 25 percent.

Zenor soils are similar to Ridgeport and Salida soils and are commonly adjacent to Clarion and Storden soils on the landscape. Ridgeport and Salida soils have less clay in the lower portion of the 10- to 40-inch control section. Clarion and Storden soils are finer textured and formed in glacial till.

Typical pedon of Zenor sandy loam, 5 to 9 percent slopes, 1,215 feet east and 2,120 feet north of the SW corner of sec. 22, T. 85 N., R. 25 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; black (10YR 2/1) coatings on peds; moderate medium subangular blocky structure parting to weak fine granular; friable; estimated 12 percent gravel; neutral; clear smooth boundary.

A3—8 to 12 inches; dark brown (10YR 3/3) and brown (10YR 4/3) sandy loam, brown (10YR 4/3) dry; moderate medium subangular blocky structure parting to weak fine subangular blocky; very friable; estimated 12 percent gravel; neutral; clear smooth boundary.

B21—12 to 17 inches; brown (10YR 4/3) loam; dark brown (10YR 3/3) coatings on peds; weak medium to fine subangular blocky structure; very friable; estimated 6 percent gravel; neutral; gradual smooth boundary.

B22—17 to 25 inches; dark yellowish brown (10YR 4/4) loam; brown (10YR 4/3) coatings on peds; weak medium and fine subangular blocky structure; very friable; estimated 6 percent gravel; neutral; gradual smooth boundary.

B3—25 to 28 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine subangular blocky structure; very friable; silt lenses in the lower part; estimated 5 percent gravel; very slight effervescence; moderately alkaline; abrupt smooth boundary.

C1—28 to 33 inches; yellowish brown (10YR 5/4) sandy loam; single grained; loose; estimated 5 percent gravel; strong effervescence; moderately alkaline; gradual smooth boundary.

IIC2—33 to 38 inches; yellowish brown (10YR 5/4) loamy sand; single grained; loose; estimated 5 percent gravel; strong effervescence; moderately alkaline; gradual smooth boundary.

IIC3—38 to 45 inches; yellowish brown (10YR 5/4) loamy sand; single grained; loose; estimated 5 percent gravel; strong effervescence; moderately alkaline; gradual smooth boundary.

IIC4—45 to 51 inches; light yellowish brown (10YR 2.5Y 6/4) loamy sand; single grained; loose; estimated 5 percent gravel; strong effervescence; moderately alkaline; gradual smooth boundary.

IIC5—51 to 60 inches; yellowish brown (10YR 5/4) sand; single grained; loose; estimated 5 percent gravel; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The mollic epipedon is 7 to 16 inches thick.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. It is sandy loam or loam. The B2 horizon has value of 4 or 5 and chroma of 3 through 5. It is sandy loam or loam. Reaction is neutral or slightly acid. The IIC horizon is loamy sand, gravelly loamy sand, gravelly sand, or sand.

formation of the soils

This section discusses the factors of soil formation, relates them to the formation of the soils in Boone County, and explains the processes of soil horizon differentiation.

factors of soil formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated as a result of geologic events. The characteristics of soil at any given point are determined by (a) the physical and mineralogical composition of the parent material, (b) the climate under which the soil material has accumulated and existed since accumulation, (c) the plant and animal life on and in the soil, (d) the relief, or lay of the land, and (e) the length of time the soil forming processes have acted on the soil material (*8*).

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of profile that forms and, in extreme cases, determines profile formation almost entirely. Also, time is needed for parent material to change into a soil. A long time is generally required for development of distinct soil horizons.

The factors of soil formation are so closely interrelated that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are not fully known.

parent material

The accumulation of parent material is the first step in the development of a soil. Most of the soils formed in material that was transported from the site of the parent rock and deposited at a new location through the action of glacial ice, water, wind, or gravity.

The soils of Boone County formed in several kinds of parent material, including glacial till and sediment from glacial till, glacial outwash, alluvium, deposits of organic material, lacustrine sediment, material weathered from shale, and material reworked by wind.

Glacial till is the parent material of most of the soils. The area that is now Boone County was subjected to three stages of glaciation—the Nebraskan, the Kansan, and the Wisconsinan. Most of the soils formed in glacial till deposited by the most recent, the Wisconsinan Glaciation.

Boone County is in the south-central part of the Des Moines Lobe of the Wisconsinan Glaciation, an area of till deposited during the Cary substage (*11, 12*). Radiocarbon dates from the base of the till in the southern part of the lobe indicate that this till was deposited about 14,000 years ago. The poorly developed surface drainage system and numerous closed depressions in this area are evidence of its geologic youth.

Among the soils that formed in glacial till are Storden, Clarion, Nicollet, Lester, Le Sueur, Hayden, and Luther soils. Canisteo, Webster, and Harps soils are in lower areas on the landscape, and they formed in glacial till and glacial sediment or reworked glacial till (*25, 26*).

Salida and Zenor soils formed in coarse textured glacial outwash material and in moraines. Ames, Blue Earth, and Okoboji soils formed in alluvial sediment derived from till that in many places washed from nearby slopes.

Alluvium consists of sediment deposited by water along major and minor streams and drainageways and on benches. Some of the alluvium has been transported only a short distance and is called local alluvium. Such alluvium retains many of the characteristics of the soils from which it washed. Moingona and Terril soils, for example, are generally at the base of slopes, below soils that formed in glacial till. Their texture is similar to that of the soils upslope.

When streams overflow their channels, the coarser textured silt and sand are deposited first in areas adjacent to the stream. The flow of water is slowed as the water spreads outward toward the uplands. Generally, the finer particles are deposited farthest from the stream channel, and the finer textured soils form there. Some of the soils in Boone County demonstrate this pattern. The finer textured Spillville, Coland, and Calco soils, for example, tend to be farther from the channel than Buckney soils, which are generally nearest the stream. This pattern has many exceptions, especially along the smaller streams.

Some soils formed in loamy alluvium underlain by sand and gravel, for example, Ridgeport, Wadena, Cylinder, Biscay, and Talcot soils. These soils are mainly on benches near streams, but some are on higher benches

along the Des Moines River. Along Beaver Creek, in the western part of the county, benches are more than 40 inches to sand and gravel. The material in which these soils formed is presumed to have been deposited by melt waters from the receding Cary glacial ice.

Along the northern edge of the county, particularly in the northwest, the soils formed in lacustrine sediment and underlying glacial till. These soils include Guckeen and Marna soils. The lacustrine sediment is thought to have been deposited by the still water of lakes along the margin of the glacial ice, rather than by fast-moving melt water. These sedimentary deposits are mainly 24 to 48 inches thick over the underlying glacial till.

Sandstone and shale are the oldest parent materials in the county (fig 12). They were deposited during the Pennsylvanian and Permian Periods (*5*). The bedrock from which the soils in Boone County formed consists mainly of shale. The nearly vertical ledges in Ledges State Park are sandstone outcroppings capped with glacial material. Soils that formed in material that weathered directly from sandstone are very few and in areas too small to delineate on the maps. Jacwin soils, for example, formed in material that weathered directly from shale.

Organic matter consists of accumulations of plant material in old lake beds and deep closed depressions.

Figure 12.—Layers of sandstone and shale bedrock are exposed in this cutbank in a gravel pit.

These swampy areas once supported a thick growth of water-loving plants that have decomposed to form muck. The organic material ranges from 20 inches to 20 feet in thickness and is underlain by glacial sediment and, at a greater depth, by glacial till (*25*). Palms soils formed in the thinner muck deposits. The ponded Palms soils formed in muck deposits that still have standing water throughout the year.

climate

The soils of Boone County formed under variable climatic conditions (*25*). In the post-Cary glaciation period, 13,000 to 10,500 years ago, the climate was cool, and conifers were the dominant vegetation. From 10,500 to about 8,000 years ago, the climate became warmer, and the vegetation changed from conifers to mixed hardwood trees. About 8,000 years ago, the climate became warmer and drier, and herbaceous prairie vegetation became dominant. Studies of the forest-prairie transition areas in central Iowa indicate that a change in postglacial climate from relatively dry to more moist conditions took place about 3,000 years ago (*9*). The present climate is midcontinental subhumid.

The climate throughout the county is nearly uniform. However, the effect of the climate is modified by local conditions, for example, relief. The microclimate on south-facing slopes is warmer and less humid than the average climate of nearby areas. North- and east-facing slopes tend to be cooler and moister than the south-facing slopes, and natural stands of trees are more likely to grow well. Low-lying or depressional, poorly drained or very poorly drained soils are wetter and colder than those in most of the surrounding areas.

Climate has had an important overall influence on the characteristics of the soils in Boone County, but it has not caused major differences among them. Local climatic differences influence the characteristics of the soils and account for some of the differences in soils within the same climatic region.

Climate interacts with the other forces of soil formation. Weathering of the parent material by water and air is activated by changes in temperature. Rainfall influences the formation of the soils through its effect on the amount of leaching in soils and on the kinds of plants that grow. Variations in plant and animal life are caused by variations in temperature or by the action of other climatic forces on the soil material.

plant and animal life

Living organisms are important in the formation of soils. The activities of burrowing animals, for example, worms, crayfish, and micro-organisms, are reflected in soil properties. Differences in the kind of vegetation, however, commonly cause the most marked differences in soils (*10*). The soils of Boone County appear to have been influenced in recent times by prairie grasses or trees, or both.

Because grasses decay in or on the soil, soils that formed under prairie vegetation typically have a thicker, darker colored surface layer than soils that formed under trees. In soils that formed under trees, the organic matter, derived principally from leaves, was deposited mainly on the surface. Soils that formed under trees generally are more acid and have more downward movement of bases and clay.

Clarion and Nicollet soils are typical of the soils in Boone County that formed in glacial till under prairie vegetation. Canisteo and Webster soils, which are poorly drained, also formed under prairie vegetation, but the native vegetation was grasses and sedges tolerant of wetness. The very poorly drained Okoboji soils formed under a native vegetation of sedges, cattails, and other plants tolerant of wetness.

Hayden and Luther soils are among those that formed under forest vegetation. These soils have a thin, light-colored A1 horizon, a prominent, grayish A2 horizon that is very distinct when dry, and a B horizon that has stronger structure and more evidence of the accumulation of clay than the soils that formed under prairie vegetation.

Lester and Le Sueur soils have properties intermediate between those of soils that formed entirely under trees and those that formed under grasses. These soils may have formed first under prairie grasses and later under trees that encroached on the prairie. Their morphology reflects the influence of both trees and grasses.

relief

In Boone County, the relief, or topography, ranges from nearly level to very steep. Relief is an important factor in soil formation because it affects drainage, runoff, the height of the water table, and erosion. A difference in topography is the main reason for the different properties of some of the soils in the county.

The thickness and color of the A horizon and the thickness of the solum are related to slope because slope affects erosion and on the amount of water that runs off or percolates through the soil. For example, differences in the thickness and color of the A horizon of Storden, Clarion, and Nicollet soils, which formed in similar parent material, are related to topography. Storden soils are mainly strongly sloping to steep, Clarion soils are mainly gently sloping or moderately sloping, and Nicollet soils are mainly nearly level. As the slope decreases, the thickness of the A horizon increases, and the color darkens. Likewise, the thickness of the solum increases and depth to carbonates increases from the Storden soils to the Clarion and Nicollet soils. In soils that have a wide range in slope, the depth to carbonates and the thickness of the solum

decrease as the slope increases and becomes more complex. In Boone County this pattern is best exemplified by the gently sloping to very steep Hayden soils.

Relief affects the color of the B horizon through its effect on drainage and soil aeration. The subsoil of a soil that has good drainage generally is brown because iron compounds are well distributed throughout the horizon and are oxidized. On the other hand, if a soil has restricted drainage or poor aeration because of wetness and a high water table, the subsoil is generally grayish and mottled. Canisteo and Okoboji soils are examples of poorly drained and very poorly drained, nearly level and depressional soils in which evidence of wetness is expressed in the soil profile. Clarion soils are well drained and have a brownish B horizon. Nicollet soils are somewhat poorly drained and have a grayish brown B horizon, indicating that they are intermediate in drainage.

time

The passage of time enables relief, climate, and plant and animal life to bring about changes in parent material. If these factors of soil development are active for long periods of time, very similar kinds of soils are formed from widely different kinds of parent material. But soil formation is generally interrupted by geologic events that expose new parent material. In Boone County, new parent material has been added to the uplands at least four times (*16*). The bedrock was twice covered by glacial till, and then loess was deposited. Another glacier subsequently deposited the present surface material. But geologic erosion has once again exposed shale, sandstone, and other bedrock in the valley of the Des Moines River and other streams. These are the oldest of the parent materials in the county. Jacwin soils formed in these materials.

Radiocarbon dates from the base of the Cary glacial drift in the southern part of the Des Moines lobe indicate that the drift was deposited about 14,000 years ago (*11*). Thus, all soils that formed from this drift are 14,000 years old or younger. In much of Iowa, including parts of Boone County, geologic erosion has beveled side slopes and, in places, deposited new sediment downslope (*13*). The surface of nearly level upland divides is older than the slopes that bevel and ascend to the divides. The side slopes, therefore, are less than 14,000 years old. Clarion, Hayden, and Lester soils are on side slopes.

The sediment that washed from side slopes accumulated to form local alluvium. By dating the alluvial fill at the base of slopes, the age of the side slopes can be determined. Some of the alluvium is less than 3,000 years old (*25*). Because sediment from the side slopes accumulated to form the alluvium, the surface of the side slopes in these areas is 3,000 years old or younger. Moingona, Terril, Spillville, and Coland soils formed in this alluvium.

processes of soil horizon differentiation

Horizon differentiation is considered to be the result of addition, removal, transfer, and transformation in the soil system (*15*). Each of these four kinds of changes affects many substances that make up soils. For example, there may be addition, removal, transfer, or transformation of organic matter, soluble salts, carbonates, sesquioxides, or silicate clay minerals.

Generally these processes promote horizon differentiation, but in some soils they offset or retard it. Various processes proceed simultaneously in soils, and the ultimate nature of the profile is governed by the balance of the changes.

The accumulation of organic matter has been an important process of soil horizon differentiation in Boone County. The addition of organic matter is generally an early step in the process of horizon differentiation. The amount of organic matter that has accumulated in the A1 horizon of soils in Boone County ranges from very high to very low. Hayden and Storden soils, for example, have a thin A1 horizon and are low in content of organic matter. Okoboji and Coland soils have a thick A1 horizon and are very high and high in content of organic matter. Some soils that formerly had a high content of organic matter now have a low content because of erosion.

The removal of substances from parts of the soil profile also is important in the differentiation of soil horizons in Boone County. The downward movement of calcium carbonates and bases in soils is an example. Many of the soils in the county have been leached of calcium carbonates in the upper part of the profile, and a few have been so strongly leached that they are medium acid or strongly acid in some horizons. However, some soils are calcareous throughout, for example, Canisteo, Crippen, Harps, and Storden soils.

Several kinds of transfers of substances from one horizon to another are evident in the soils of Boone County. For example, phosphorus is removed from the subsoil by plant roots and is transferred to other parts of the plant. It is later added to the surface layer through the plant residue.

The translocation of clay is an important process in the differentiation of soil horizons. In Boone County the clay is made up mainly of silicate clay minerals. It is carried downward, suspended in percolating water, from the A horizon to the B horizon. In the B horizon it accumulates in pores and root channels and in clay films on the faces of peds. Translocation of clay has had an influence on the profile of many of the soils, for example, Hayden and Dundas soils. In some soils, the content of clay in the A and B horizons is not markedly different, and only a minimal movement of clay is indicated.

A transformation is physical or chemical, or both. An example of physical transformation is the weathering of soil particles to a smaller size. Another kind of transformation is the reduction of iron by a process

called gleying, in which soil is saturated for long periods in the presence of organic matter. A soil in which gleying has taken place is characterized by the presence of ferrous iron and gray colors. Reductive and extractable iron is commonly less abundant in poorly drained soils, for example, Webster soils, than in the better drained soils, for example, Nicollet and Clarion soils (*21*).

Still another kind of transformation is the weathering of the primary apatite mineral in parent material to secondary phosphorus compounds. The pH value of the soil must decline to about 7 before appreciable amounts of weathering take place (*6, 14*). For example, Storden soils are calcareous, and their subsoil is very low in available phosphorus. In Hayden soils, which are leached and have a medium acid subsoil, the amount of available phosphorus is higher.

references

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D. 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Boone Soil Conservation District. 1971. Twenty-fifth anniversary report.

(4) Goldthwait, N. E. 1914. History of Boone County. Pioneer Publishing Co. Vol. 1. 535 pp.

(5) Hale, William E. 1955. Geology and ground water resources of Webster County, Iowa. Iowa Geol. Surv. Bull. 4, 257 pp., illus.

(6) Hsu, P. H. and M. L. Jackson. 1960. Inorganic phosphate transformations by chemical weathering in soils as influenced by pH. Soil. Sci. 90: 16-24, illus.

(7) Iowa Department of Agriculture, Division of Agricultural Statistics. 1974 Annual farm census township survey.

(8) Jenny, Hans. 1941. Factors of soil formation. McGraw-Hill Book Company, Inc., 281 pp., illus.

(9) McComb, A. L. and W. E. Loomis. 1944. Subclimax prairie. Torrey Bot. Clay. Bull. 71: 45-76.

(10) McComb, A. L., W. E. Loomis, and F. F. Riecken. 1961. Effect of vegetation on soils in the forest-prairie region. Rec. Adv. Bot., Univ. Toronto Press, pp. 1627-1631.

(11) Ruhe, Robert V. 1969. Quaternary landscapes in Iowa. Iowa State Univ. Press, 255 pp., illus.

(12) Ruhe, R. V. and W. H. Scholte. 1959. Important elements in the Wisconsin glacial stage: a discussion. J. Geol. 67: 585-593.

(13) Ruhe, R. V., R. B. Daniels, and J. G. Cady. 1967. Landscape evolution and soil formation in southwestern Iowa. U.S. Dep. Agric. Tech. Bull. 1349: 242 pp., illus.

(14) Runge, E. C. A. and F. F. Riecken. 1966. Influence of natural drainage on the distribution and forms of phosphorus in some Iowa prairie soils. Soil Sci. Soc. Am Proc. 30: 624-630, illus.

(15) Simonson, Roy W. 1959. Outline of a generalized theory of soil genesis. Soil Sci. Soc. Am. Proc. 23: 152-156, illus.

(16) Simonson, R. W., F. F. Riecken, and G. D. Smith. 1952. Understanding Iowa soils. 142 pp., illus.

(17) Union Historical Company of Washington, D. C. 1880. The history of Boone County, Iowa. 680 pp., illus.

(18) United States Department of Agriculture. 1923. Soil survey of Boone County, Iowa.

(19) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(20) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210, 21 pp.

(21) United States Department of Agriculture. 1966. Soil laboratory data and descriptions for some soils of Iowa. Soil Conserv. Serv. in coop. Iowa Agric. Exp. Stn. Soil Surv. Invest. Rep. 3, 181 pp.

(22) United States Department of Agriculture. 1970. Iowa soil and water conservation needs inventory. 229 pp.

(23) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(24) United States Department of Agriculture and Iowa Department of Agriculture. 1975. Iowa agriculture statistics. 69 pp.

(25) Walker, Patrick H. 1966. Postglacial environments in relation to landscape and soils on the Cary Drift, Iowa. Iowa Agric. & Home Econ. Exp. Stn., Iowa State Univ. Resour. Bull. 549, pp. 838-875.

(26) White, Everett M. 1953. Subsoil texture variations on the Clarion-Webster Experiment Farm as related to the Mankato glacial deposit. Iowa Acad. Sci. 60: 438-441.

glossary

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated

compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. The method of preparing a seedbed with a minimum of soil disturbance and leaving the needed amount of crop residue on the surface to protect the soils.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as

(1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an

arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A1, A2, or A3) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide

range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-74, at Boone, Iowa]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	27.4	7.9	17.7	54	-22	0	.99	.41	1.45	2	7.2
February---	33.7	14.1	23.9	59	-16	0	1.17	.35	1.82	3	7.3
March------	43.7	23.6	33.7	77	-5	32	2.03	1.02	2.84	5	7.5
April------	61.0	37.6	49.3	87	17	92	3.24	1.85	4.36	6	1.2
May--------	73.0	49.1	61.1	91	29	351	4.72	2.89	6.35	8	.0
June-------	82.1	58.4	70.3	97	42	609	5.27	3.13	7.17	7	.0
July-------	86.3	62.4	74.4	100	47	756	4.01	2.06	5.59	7	.0
August-----	84.2	60.0	72.1	98	44	685	3.60	1.54	5.27	6	.0
September--	75.8	50.6	63.3	93	32	399	3.45	1.16	5.26	6	.0
October----	65.7	40.6	53.2	88	19	176	2.38	.74	3.68	5	.1
November---	47.2	26.9	37.1	74	2	7	1.42	.40	2.23	3	2.9
December---	33.3	15.4	24.4	59	-16	0	1.14	.53	1.63	3	6.6
Year-----	59.5	37.2	48.4	100	-22	3,107	33.42	27.54	38.97	61	32.8

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-74, at Boone, Iowa]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 22	May 5	May 15
2 years in 10 later than--	April 18	April 30	May 9
5 years in 10 later than--	April 9	April 20	April 29
First freezing temperature in fall:			
1 year in 10 earlier than--	October 13	October 1	September 25
2 years in 10 earlier than--	October 18	October 6	September 29
5 years in 10 earlier than--	October 28	October 16	October 7

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-74, at Boone, Iowa]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	184	157	144
8 years in 10	190	165	150
5 years in 10	201	178	161
2 years in 10	212	192	171
1 year in 10	218	199	177

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
6	Okoboji silty clay loam, 0 to 1 percent slopes	4,025	1.1
27C	Terril loam, 5 to 9 percent slopes	1,140	0.3
28B	Dickman fine sandy loam, 1 to 5 percent slopes	815	0.2
28C	Dickman fine sandy loam, 5 to 9 percent slopes	665	0.2
55	Nicollet loam, 1 to 3 percent slopes	42,530	11.6
62C2	Storden loam, 5 to 9 percent slopes, moderately eroded	1,700	0.5
62D2	Storden loam, 9 to 14 percent slopes, moderately eroded	4,180	1.1
62E2	Storden loam, 14 to 18 percent slopes, moderately eroded	1,660	0.5
62F	Storden loam, 18 to 25 percent slopes	785	0.2
73D	Salida gravelly sandy loam, 5 to 14 percent slopes	535	0.1
73F	Salida gravelly sandy loam, 14 to 25 percent slopes	725	0.2
90	Okoboji mucky silt loam, 0 to 1 percent slopes	5,035	1.4
95	Harps loam, 0 to 2 percent slopes	12,930	3.5
107	Webster silty clay loam, 0 to 2 percent slopes	30,660	8.4
135	Coland clay loam, 0 to 2 percent slopes	6,500	1.8
138B	Clarion loam, 2 to 5 percent slopes	58,130	15.9
138C	Clarion loam, 5 to 9 percent slopes	11,160	3.0
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded	14,195	3.9
138D2	Clarion loam, 9 to 14 percent slopes, moderately eroded	1,385	0.4
167	Ames silt loam, 0 to 1 percent slopes	225	0.1
168B	Hayden loam, 2 to 5 percent slopes	8,215	2.2
168C	Hayden loam, 5 to 9 percent slopes	1,920	0.5
168C2	Hayden loam, 5 to 9 percent slopes, moderately eroded	900	0.2
168D2	Hayden loam, 9 to 14 percent slopes, moderately eroded	510	0.1
168E	Hayden loam, 14 to 18 percent slopes	500	0.1
203	Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,080	0.3
221	Palms muck, 0 to 1 percent slopes	505	0.1
224	Linder sandy loam, 0 to 2 percent slopes	250	0.1
236B	Lester loam, 2 to 5 percent slopes	3,695	1.0
236C2	Lester loam, 5 to 9 percent slopes, moderately eroded	1,065	0.3
259	Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	915	0.2
307	Dundas silt loam, 0 to 2 percent slopes	1,185	0.3
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	455	0.1
308B	Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes	625	0.2
325	Le Sueur loam, 0 to 2 percent slopes	2,235	0.6
335	Harcot loam, 0 to 2 percent slopes	360	0.1
354	Palms muck, ponded, 0 to 1 percent slopes	205	0.1
355	Luther loam, 0 to 2 percent slopes	2,635	0.7
356G	Hayden-Storden loams, 25 to 50 percent slopes	19,645	5.4
383	Marna silty clay loam, 0 to 2 percent slopes	1,115	0.3
385B	Guckeen clay loam, 1 to 4 percent slopes	410	0.1
444C	Jacwin loam, 3 to 9 percent slopes	205	0.1
485	Spillville loam, 0 to 2 percent slopes	990	0.3
485B	Spillville loam, 2 to 5 percent slopes	2,230	0.6
507	Canisteo silty clay loam, 0 to 2 percent slopes	83,690	22.8
511	Blue Earth mucky silt loam, 0 to 1 percent slopes	580	0.2
536	Hanlon fine sandy loam, 0 to 2 percent slopes	725	0.2
559	Talcot clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	1,360	0.4
566B	Moingona loam, 1 to 5 percent slopes	950	0.3
566C	Moingona loam, 5 to 9 percent slopes	1,005	0.3
566D	Moingona loam, 9 to 14 percent slopes	215	0.1
585B	Coland-Spillville complex, 2 to 5 percent slopes	3,735	1.0
636	Buckney fine sandy loam, 1 to 3 percent slopes	595	0.2
639D	Storden-Salida complex, 9 to 14 percent slopes	260	0.1
639E	Storden-Salida complex, 14 to 25 percent slopes	350	0.1
655	Crippin loam, 1 to 3 percent slopes	1,390	0.4
733	Calco silty clay loam, 0 to 2 percent slopes	330	0.1
778	Sattre loam, 0 to 2 percent slopes	520	0.1
778B	Sattre loam, 2 to 5 percent slopes	785	0.2
778C	Sattre loam, 5 to 9 percent slopes	225	0.1
823	Ridgeport sandy loam, 0 to 2 percent slopes	500	0.1
823B	Ridgeport sandy loam, 2 to 5 percent slopes	445	0.1
823C2	Ridgeport sandy loam, 5 to 9 percent slopes, moderately eroded	325	0.1
828B	Zenor sandy loam, 2 to 5 percent slopes	910	0.2
828C	Zenor sandy loam, 5 to 9 percent slopes	485	0.1
828C2	Zenor sandy loam, 5 to 9 percent slopes, moderately eroded	2,090	0.6
829D2	Zenor-Storden complex, 9 to 14 percent slopes, moderately eroded	1,015	0.3
829E2	Zenor-Storden complex, 14 to 25 percent slopes, moderately eroded	335	0.1
1135	Coland clay loam, channeled, 0 to 2 percent slopes	3,570	1.0
1636	Buckney fine sandy loam, channeled, 0 to 2 percent slopes	2,520	0.7
2485B	Spillville-Buckney complex, 2 to 5 percent slopes	1,945	0.5
4055	Nicollet-Urban land complex, 1 to 3 percent slopes	605	0.2

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
4138B	Clarion-Urban land complex, 2 to 5 percent slopes	1,150	0.3
4138C	Clarion-Urban land complex, 5 to 9 percent slopes	200	0.1
4507	Canisteo-Urban land complex, 0 to 2 percent slopes	880	0.2
5010	Pits, gravel	540	0.1
5020	Dumps, mine	115	*
5040	Orthents, loamy	490	0.1
	Water	895	0.2
	Total	366,560	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Smooth bromegrass	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
6 Okoboji	84	32	59	3.4	4.3	7.3	3.3
27C Terril	110	42	77	4.6	6.7	8.0	4.2
28B Dickman	50	20	45	2.5	---	3.7	1.2
28C Dickman	45	18	40	2.2	---	3.7	1.2
55 Nicollet	121	46	85	5.1	---	6.5	3.5
62C2 Storden	97	37	68	4.1	---	5.0	3.0
62D2 Storden	77	29	54	3.2	---	---	2.7
62E2 Storden	---	---	---	2.5	---	4.5	2.5
62F Storden	---	---	---	2.0	---	3.7	2.0
73D Salida	---	---	15	0.8	---	3.7	1.5
73F Salida	---	---	---	---	---	---	0.8
90 Okoboji	86	33	60	3.4	4.3	7.3	3.3
95 Harps	90	34	63	3.6	5.0	6.6	3.3
107 Webster	113	43	79	4.5	6.6	7.3	4.2
135 Coland	102	39	71	4.1	6.0	7.6	4.1
138B Clarion	113	44	79	4.7	6.7	7.6	4.2
138C Clarion	107	41	75	4.5	6.3	7.3	3.8
138C2 Clarion	104	40	73	4.4	6.2	7.1	3.8
138D2 Clarion	93	36	65	3.9	5.5	6.5	3.7
167 Ames	74	28	52	3.0	3.7	5.0	2.7
168B Hayden	100	38	70	4.2	---	6.5	3.5

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Smooth bromegrass	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
168C----------------------- Hayden	95	36	66	4.0	---	6.5	3.5
168C2---------------------- Hayden	92	35	64	3.9	---	6.5	3.5
168D2---------------------- Hayden	83	32	58	3.5	---	6.0	3.5
168E----------------------- Hayden	71	27	50	3.0	---	6.0	3.0
203------------------------ Cylinder	105	40	73	4.4	6.2	7.1	3.8
221------------------------ Palms	80	30	56	3.2	---	---	---
224------------------------ Linder	55	19	38	2.0	3.7	4.1	2.3
236B----------------------- Lester	106	41	74	4.5	---	6.5	3.5
236C2---------------------- Lester	94	36	66	4.0	---	6.3	3.3
259------------------------ Biscay	102	39	71	4.1	---	5.2	3.0
307------------------------ Dundas	100	38	70	4.0	---	5.0	3.8
308------------------------ Wadena	94	36	66	4.0	---	6.2	3.6
308B----------------------- Wadena	92	35	64	3.9	---	6.0	3.7
325------------------------ Le Sueur	115	44	80	4.8	---	6.7	4.7
335------------------------ Harcot	82	31	57	3.3	4.8	6.0	3.1
354. Palms							
355------------------------ Luther	108	35	76	4.5	6.3	7.5	3.8
356G. Hayden-Storden							
383------------------------ Marna	98	37	69	3.9	---	6.0	---
385B----------------------- Guckeen	106	41	74	4.5	---	6.7	4.7
444C----------------------- Jacwin	70	30	49	2.9	4.1	4.6	2.6
485------------------------ Spillville	122	46	85	5.1	7.3	8.6	4.2

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Smooth bromegrass	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
485B Spillville	120	46	84	5.0	7.2	8.5	4.1
507 Canisteo	107	41	75	4.3	---	5.2	3.0
511 Blue Earth	97	37	68	3.9	---	---	---
536 Hanlon	92	35	64	3.3	5.3	6.3	3.3
559 Talcot	97	37	68	3.9	6.0	6.3	4.8
566B Moingona	113	43	79	4.7	5.5	7.6	4.1
566C Moingona	109	42	76	4.6	5.3	7.5	3.8
566D Moingona	100	39	70	4.2	4.9	6.8	3.7
585B Coland-Spillville	108	41	76	4.3	6.5	7.9	4.0
636 Buckney	74	28	52	2.7	---	---	---
639D Storden-Salida	51	19	36	1.8	---	4.6	2.5
639E Storden-Salida	32	11	22	1.2	---	---	1.6
655 Crippin	107	40	75	4.5	6.5	7.1	4.2
733 Calco	95	35	71	4.0	5.3	7.0	6.0
778 Sattre	93	35	65	3.9	5.5	6.5	3.7
778B Sattre	91	34	64	3.8	5.3	6.3	3.5
778C Sattre	86	33	60	3.6	5.1	6.0	3.3
823 Ridgeport	53	20	42	2.2	3.2	3.6	1.7
823B Ridgeport	51	19	41	2.1	3.1	3.5	1.5
823C2 Ridgeport	43	13	36	1.8	2.7	3.0	1.1
828B Zenor	70	28	56	2.9	4.8	4.8	2.6
828C Zenor	65	26	48	2.7	4.5	4.5	2.3

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Smooth bromegrass	Bromegrass-alfalfa	Kentucky bluegrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
828C2 Zenor	62	23	43	2.4	4.3	4.3	2.1
829D2 Zenor-Storden	61	24	42	2.2	4.1	4.1	2.1
829E2 Zenor-Storden	---	---	---	2.0	3.8	3.8	2.0
1135 Coland	---	---	---	3.0	---	---	4.1
1636 Buckney	---	---	---	2.5	---	---	---
2485B. Spillville-Buckney							
4055. Nicollet-Urban land							
4138B. Clarion-Urban land							
4138C. Clarion-Urban land							
4507. Canisteo-Urban land							
5010. Pits							
5020. Dumps							
5040. Orthents							

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 6.--CAPABILITY CLASSES AND SUBCLASSES

[Miscellaneous areas are excluded. Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns (Subclass)		
		Erosion (e)	Wetness (w)	Soil problem (s)
		Acres	Acres	Acres
I	49,915	---	---	---
II	224,826	82,796	139,520	2,510
III	56,121	45,756	9,865	500
IV	4,119	3,499	---	620
V	7,862	---	7,862	---
VI	1,186	1,186	---	---
VII	30,307	29,467	---	840
VIII	---	---	---	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
6 Okoboji	Silky dogwood, redosier dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Laurel willow, Amur maple, Zabel honeysuckle, northern white-cedar.	Green ash	Silver maple, eastern cottonwood.
27C Terril	Redosier dogwood, gray dogwood.	Siberian dogwood, Tatarian honeysuckle, bloodtwig dogwood.	Amur maple, eastern redcedar.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern cottonwood.
28B, 28C Dickman	---	Siberian crabapple, Amur honeysuckle, lilac.	Eastern redcedar, blue spruce, Austrian pine, northern white-cedar, common hackberry, red pine, white spruce, bur oak.	Green ash	---
55 Nicollet	---	Gray dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple, eastern redcedar.	Red pine, eastern white pine, green ash, common hackberry.	---
62C2, 62D2 Storden	---	Tatarian honeysuckle, Siberian honeysuckle, Siberian peashrub, northern white-cedar.	Eastern redcedar, Siberian crabapple.	Green ash, Russian-olive, common hackberry.	---
62E2, 62F. Storden					
73D Salida	---	Eastern redcedar, northern white-cedar, Russian-olive, Tatarian honeysuckle.	Common hackberry, bur oak, red pine.	---	---
73F. Salida					
90 Okoboji	Silky dogwood, redosier dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Laurel willow, Amur maple, Zabel honeysuckle, northern white-cedar.	Green ash	Silver maple, eastern cottonwood.
95 Harps	Redosier dogwood, silky dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Zabel honeysuckle, Siberian dogwood.	Laurel willow, northern white-cedar, Amur maple.	Green ash	Eastern cottonwood, silver maple.
107 Webster	Silky dogwood, redosier dogwood.	Zabel honeysuckle, bloodtwig dogwood, Siberian dogwood, Tatarian honeysuckle.	Laurel willow, northern white-cedar, Amur maple.	Green ash	Silver maple, eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
135---------------- Coland	Redosier dogwood, silky dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Zabel honeysuckle, Siberian dogwood.	Laurel willow, northern white-cedar, Amur maple.	Green ash----------	Eastern cottonwood, silver maple.
138B, 138C, 138C2, 138D2------------ Clarion	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Eastern redcedar, Russian-olive.	Red pine, Norway spruce, common hackberry, green ash.	---
167---------------- Ames	Redosier dogwood, silky dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Zabel honeysuckle, Siberian dogwood.	Laurel willow, northern white-cedar, Amur maple.	Green ash----------	Eastern cottonwood, silver maple.
168B, 168C, 168C2, 168D2------------ Hayden	---	Gray dogwood, Tatarian honeysuckle, lilac.	Siberian crabapple, Amur maple, northern white-cedar, white spruce.	Eastern white pine, green ash, common hackberry, ponderosa pine.	Eastern cottonwood.
168E. Hayden					
203---------------- Cylinder	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Red pine, Norway spruce, common hackberry.	Silver maple, eastern cottonwood.
221---------------- Palms	Gray dogwood, dwarf purple willow.	Amur honeysuckle, redosier dogwood, silky dogwood.	Northern white-cedar, tall purple willow, medium purple willow.	---	Lombardy poplar.
224---------------- Linder	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Norway spruce, common hackberry, eastern white pine.	Silver maple, eastern cottonwood.
236B, 236C2-------- Lester	---	Gray dogwood, Tatarian honeysuckle, lilac.	Siberian crabapple, Amur maple, northern white-cedar.	Eastern white pine, green ash, common hackberry.	Eastern cottonwood, silver maple.
259---------------- Biscay	---	Northern white-cedar, redosier dogwood, medium purple willow, Tatarian honeysuckle.	Amur maple, white spruce, eastern white pine.	Silver maple, green ash, golden willow, common hackberry.	Eastern cottonwood.
307---------------- Dundas	---	Northern white-cedar, Tatarian honeysuckle, lilac, redosier dogwood.	Norway spruce, eastern white pine, Amur maple.	Golden willow, green ash, silver maple, common hackberry.	Eastern cottonwood.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
308, 308B: Wadena	---	Siberian crabapple, gray dogwood, Tatarian honeysuckle, lilac.	Eastern redcedar, northern white-cedar, white spruce, red pine, common hackberry, bur oak.	Green ash	Eastern cottonwood.
325: Le Sueur	---	Gray dogwood, Tatarian honeysuckle, lilac, redosier dogwood.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple, eastern redcedar.	Eastern white pine, green ash, common hackberry, Norway spruce.	---
335: Harcot	Redosier dogwood, silky dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Zabel honeysuckle, Siberian dogwood.	Laurel willow, northern white-cedar, Siberian crabapple.	Green ash	Eastern cottonwood.
354: Palms	Gray dogwood, dwarf purple willow.	Redosier dogwood, silky dogwood.	Northern white-cedar, tall purple willow, medium purple willow.	---	---
355: Luther	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Eastern redcedar	Common hackberry, Norway spruce, eastern white pine, green ash.	Eastern cottonwood.
356G*:					
Hayden.					
Storden.					
383: Marna	---	Northern white-cedar, medium purple willow, Tatarian honeysuckle, redosier dogwood.	White spruce, eastern white pine, Siberian crabapple.	Golden willow, green ash, Norway spruce, common hackberry.	Eastern cottonwood.
385B: Guckeen	---	Gray dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, eastern redcedar.	Green ash, common hackberry, eastern white pine, Norway spruce.	---
444C: Jacwin	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, Norway spruce, eastern white pine.	Eastern cottonwood, silver maple.
485, 485B: Spillville	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, Norway spruce, eastern white pine.	Eastern cottonwood, silver maple.
507: Canisteo	---	Medium purple willow, redosier dogwood, Tatarian honeysuckle.	Russian-olive	Green ash	Eastern cottonwood, golden willow.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
511. Blue Earth					
536 Hanlon	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
559 Talcot	---	Tatarian honeysuckle, medium purple willow, redosier dogwood.	Russian-olive	Green ash	Eastern cottonwood, golden willow.
566B, 566C, 566D Moingona	Redosier dogwood, gray dogwood.	Bloodtwig dogwood, Tatarian honeysuckle, Siberian dogwood.	Amur maple, eastern redcedar.	Norway spruce, common hackberry, eastern white pine.	Eastern cottonwood, silver maple.
585B*: Coland	Redosier dogwood, silky dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Zabel honeysuckle, Siberian dogwood.	Laurel willow, northern white-cedar, Amur maple.	Green ash	Eastern cottonwood, silver maple.
Spillville	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, Norway spruce, eastern white pine.	Eastern cottonwood, silver maple.
636 Buckney	Silky dogwood, redosier dogwood.	Tatarian honeysuckle.	Eastern redcedar, Russian-olive.	Green ash, common hackberry, bur oak.	Eastern cottonwood.
639D*: Storden	---	Tatarian honeysuckle, Siberian peashrub, northern white-cedar.	Eastern redcedar, Siberian crab-apple.	Green ash, Russian-olive, common hackberry.	---
Salida	---	Eastern redcedar, northern white-cedar, Russian-olive, Tatarian honeysuckle.	Common hackberry, bur oak, red pine.	---	---
639E*: Storden.					
Salida.					
655 Crippin	Gray dogwood, redosier dogwood.	Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar	Green ash, common hackberry, golden willow.	Eastern cottonwood.
733 Calco	Redosier dogwood, silky dogwood.	Siberian dogwood, Tatarian honeysuckle, bloodtwig dogwood, Zabel honeysuckle.	Laurel willow, northern white-cedar.	Green ash, golden willow, common hackberry.	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
778, 778B, 778C---Sattre	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
823, 823B, 823C2--Ridgeport	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, Siberian dogwood, bloodtwig dogwood.	Eastern redcedar, Russian-olive, Siberian crab-apple.	Red pine, common hackberry, green ash.	---
828B, 828C, 828C2 Zenor	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, Norway spruce.	Eastern cottonwood, silver maple.
829D2*:					
Zenor------------	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, green ash.	Silver maple.
Storden----------	---	Tatarian honey-suckle, Siberian peashrub, northern white-cedar.	Eastern redcedar, Siberian crab-apple.	Green ash, Russian-olive, common hackberry.	---
829E2*:					
Zenor------------	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, red pine, green ash.	Silver maple.
Storden.					
1135--------------Coland	Redosier dogwood, silky dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Zabel honeysuckle, Siberian dogwood.	Laurel willow, northern white-cedar, Amur maple.	Green ash---------	Eastern cottonwood, silver maple.
1636--------------Buckney	Silky dogwood, redosier dogwood.	Tatarian honey-suckle.	Eastern redcedar, Russian-olive.	Green ash, common hackberry, bur oak.	Eastern cottonwood.
2485B*:					
Spillville-------	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Amur maple, eastern redcedar.	Common hackberry, Norway spruce, eastern white pine.	Eastern cottonwood, silver maple.
Buckney----------	Silky dogwood, redosier dogwood.	Tatarian honey-suckle.	Eastern redcedar, Russian-olive.	Green ash, common hackberry, eastern white pine.	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
4055*:					
Nicollet	---	Gray dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, Siberian crabapple, Amur maple, eastern redcedar.	Red pine, eastern white pine, green ash, common hackberry.	---
Urban land.					
4138B*, 4138C*:					
Clarion	Redosier dogwood, gray dogwood.	Tatarian honeysuckle, bloodtwig dogwood, Siberian dogwood.	Eastern redcedar, Russian-olive.	Red pine, Norway spruce, common hackberry, green ash.	---
Urban land.					
4507*:					
Canisteo	---	Medium purple willow, redosier dogwood, Tatarian honeysuckle.	Russian-olive	Green ash	Eastern cottonwood, golden willow.
Urban land.					
5010. Pits					
5020. Dumps					
5040. Orthents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
6 Okoboji	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
27C Terril	Slight	Slight	Severe: slope.	Slight	Slight.
28B Dickman	Slight	Slight	Moderate: slope.	Slight	Slight.
28C Dickman	Slight	Slight	Severe: slope.	Slight	Slight.
55 Nicollet	Slight	Slight	Moderate: slope.	Slight	Slight.
62C2 Storden	Slight	Slight	Severe: slope.	Slight	Slight.
62D2 Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
62E2, 62F Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
73D Salida	Moderate: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.	Moderate: small stones.	Severe: small stones.
73F Salida	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.
90 Okoboji	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.
95 Harps	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
107 Webster	Severe: wetness.	Moderate: wetness, too clayey.	Severe: wetness.	Moderate: wetness, too clayey.	Severe: wetness.
135 Coland	Severe: floods, wetness.	Moderate: wetness, too clayey.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: wetness, floods.
138B Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.
138C, 138C2 Clarion	Slight	Slight	Severe: slope.	Slight	Slight.
138D2 Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
167 Ames	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
168B Hayden	Slight	Slight	Moderate: slope.	Slight	Slight.
168C, 168C2 Hayden	Slight	Slight	Severe: slope.	Slight	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
168D2 Hayden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
168E Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
203 Cylinder	Slight	Slight	Slight	Slight	Slight.
221 Palms	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.
224 Linder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Moderate: wetness.
236B Lester	Slight	Slight	Moderate: slope.	Slight	Slight.
236C2 Lester	Slight	Slight	Severe: slope.	Slight	Slight.
259 Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
307 Dundas	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
308 Wadena	Slight	Slight	Slight	Slight	Slight.
308B Wadena	Slight	Slight	Moderate: slope.	Slight	Slight.
325 Le Sueur	Slight	Slight	Slight	Slight	Slight.
335 Harcot	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
354 Palms	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.
355 Luther	Moderate: wetness, percs slowly.	Moderate: wetness.	Moderate: wetness, percs slowly.	Slight	Moderate: wetness.
356G:					
Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
383 Marna	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
385B Guckeen	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight	Moderate: too clayey.
444C Jacwin	Severe: percs slowly.	Moderate: wetness.	Severe: slope, percs slowly.	Slight	Moderate: wetness.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
485 Spillville	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.	Severe: floods.
485B Spillville	Slight	Slight	Moderate: slope.	Slight	Slight.
507 Canisteo	Severe: wetness.	Moderate: wetness, too clayey.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: too clayey, wetness.
511 Blue Earth	Severe: floods, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
536 Hanlon	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.	Severe: floods.
559 Talcot	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: wetness.
566B Moingona	Slight	Slight	Moderate: slope.	Slight	Slight.
566C Moingona	Slight	Slight	Severe: slope.	Slight	Slight.
566D Moingona	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
585B:					
Coland	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, floods.
Spillville	Severe: floods.	Slight	Moderate: slope, floods.	Slight	Moderate: floods.
636 Buckney	Severe: floods.	Slight	Moderate: floods.	Slight	Moderate: floods.
639D:					
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Salida	Moderate: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.	Moderate: small stones.	Severe: small stones.
639E:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Salida	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: slope, small stones.	Severe: slope, small stones.
655 Crippin	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight	Moderate: wetness.
733 Calco	Severe: floods, wetness.	Moderate: wetness, floods.	Severe: wetness, floods.	Moderate: wetness, floods.	Severe: floods.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
778 Sattre	Slight	Slight	Slight	Slight	Slight.
778B Sattre	Slight	Slight	Moderate: slope.	Slight	Slight.
778C Sattre	Slight	Slight	Severe: slope.	Slight	Slight.
823 Ridgeport	Slight	Slight	Slight	Slight	Slight.
823B Ridgeport	Slight	Slight	Moderate: slope.	Slight	Slight.
823C2 Ridgeport	Slight	Slight	Severe: slope.	Slight	Slight.
828B Zenor	Slight	Slight	Moderate: slope.	Slight	Slight.
828C, 828C2 Zenor	Slight	Slight	Severe: slope.	Slight	Slight.
829D2:					
Zenor	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
829E2:					
Zenor	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
1135 Coland	Severe: floods, wetness.	Moderate: floods, wetness.	Severe: wetness, floods.	Moderate: wetness, floods.	Severe: floods.
1636 Buckney	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.	Severe: floods.
2485B:					
Spillville	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.	Severe: floods.
Buckney	Severe: floods.	Slight	Moderate: floods.	Slight	Moderate: floods.
4055*:					
Nicollet	Slight	Slight	Moderate: slope.	Slight	Slight.
Urban land.					
4138B*:					
Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.
Urban land.					

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
4138C*:					
Clarion	Slight	Slight	Severe: slope.	Slight	Slight.
Urban land.					
4507*:					
Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: too clayey, wetness.
Urban land.					
5010. Pits					
5020. Dumps					
5040. Orthents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
6 Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
27C Terril	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
28B, 28C Dickman	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
55 Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
62C2, 62D2, 62E2 Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
62F Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
73D Salida	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
73F Salida	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
90 Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
95 Harps	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
107 Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
135 Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
138B Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
138C, 138C2, 138D2 Clarion	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
167 Ames	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
168B Hayden	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
168C, 168C2, 168D2, 168E Hayden	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
203 Cylinder	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
221 Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Poor.
224 Linder	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
236B Lester	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
236C2: Lester	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
259: Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.
307: Dundas	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
308, 308B: Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
325: Le Sueur	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
335: Harcot	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.
354: Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Poor.
355: Luther	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
356G:										
Hayden	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
383: Marna	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
385B: Guckeen	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
444C: Jacwin	Poor	Poor	Fair	Fair	Fair	Poor	Poor	Poor	Fair	Poor.
485: Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
485B: Spillville	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
507: Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
511: Blue Earth	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
536: Hanlon	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
559: Talcot	Fair	Fair	Fair	Poor	Poor	Good	Good	Fair	Poor	Good.
566B: Moingona	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
566C, 566D: Moingona	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
585B:										
Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
585B:										
Spillville	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
636 Buckney	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
639D:										
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Salida	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
639E:										
Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Salida	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
655 Crippin	Good	Good	Good	Good	Fair	Fair	Poor	Good	Good	Poor.
733 Calco	Good	Fair	Good	Poor	Very poor.	Good	Good	Fair	Poor	Fair.
778, 778B Sattre	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
778C Sattre	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
823, 823B, 823C2 Ridgeport	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
828B Zenor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
828C, 828C2 Zenor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
829D2:										
Zenor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
829E2:										
Zenor	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
1135 Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
1636 Buckney	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
2485B:										
Spillville	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
2485B: Buckney-----------	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
4055*: Nicollet---------	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Urban land.										
4138B*: Clarion-----------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Urban land.										
4138C*: Clarion-----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Urban land.										
4507*: Canisteo----------	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
Urban land.										
5010. Pits										
5020. Dumps										
5040. Orthents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
6: Okoboji	Severe: wetness, floods.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, low strength, floods.	Severe: wetness, floods.
27C: Terril	Slight	Slight	Slight	Moderate: slope.	Severe: low strength.	Slight.
28B: Dickman	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
28C: Dickman	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Slight.
55: Nicollet	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
62C2: Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action, low strength.	Slight.
62D2: Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action, low strength.	Moderate: slope.
62E2, 62F: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
73D: Salida	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: small stones.
73F: Salida	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, small stones.
90: Okoboji	Severe: wetness, floods.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, low strength, floods.	Severe: wetness, floods.
95: Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, low strength, frost action.	Moderate: wetness.
107: Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action, wetness.	Moderate: wetness.
135: Coland	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, low strength.	Moderate: wetness, floods.
138B: Clarion	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.	Slight.
138C, 138C2: Clarion	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
138D2: Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, low strength, frost action.	Moderate: slope.
167: Ames	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: wetness, low strength, frost action.	Severe: wetness.
168B: Hayden	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
168C, 168C2: Hayden	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: low strength.	Slight.
168D2: Hayden	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
168E: Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.	Severe: slope.
203: Cylinder	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
221: Palms	Severe: wetness, excess humus, floods.	Severe: wetness, low strength, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, excess humus.
224: Linder	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Moderate: wetness.
236B: Lester	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
236C2: Lester	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: low strength.	Slight.
259: Biscay	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Moderate: wetness.
307: Dundas	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
308, 308B: Wadena	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: low strength.	Slight.
325: Le Sueur	Moderate: wetness.	Moderate: shrink-swell.	Severe: wetness.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
335: Harcot	Severe: wetness, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, frost action, low strength.	Moderate: wetness.
354: Palms	Severe: wetness, excess humus, floods.	Severe: wetness, low strength, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, excess humus.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
355 Luther	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: frost action, shrink-swell, low strength.	Moderate: wetness.
356G*:						
Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.	Severe: slope.
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
383 Marna	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, frost action, low strength.	Severe: wetness.
385B Guckeen	Moderate: wetness, too clayey.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
444C Jacwin	Moderate: wetness, too clayey.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: slope, wetness, shrink-swell.	Severe: frost action, low strength.	Slight.
485 Spillville	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.	Severe: floods.
485B Spillville	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Moderate: wetness.
507 Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
511 Blue Earth	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods.
536 Hanlon	Severe: floods, cutbanks cave.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
559 Talcot	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, low strength, frost action.	Moderate: wetness.
566B Moingona	Moderate: wetness.	Moderate: shrink-swell, low strength.	Moderate: wetness, shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.	Slight.
566C Moingona	Moderate: wetness.	Moderate: shrink-swell, low strength.	Moderate: wetness, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: low strength.	Slight.
566D Moingona	Moderate: slope, wetness.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.	Moderate: slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
585B*:						
Coland	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, low strength.	Moderate: wetness, floods.
Spillville	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.	Moderate: floods.
636 Buckney	Severe: cutbanks cave, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods.
639D*:						
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action, low strength.	Moderate: slope.
Salida	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: small stones.
639E*:						
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Salida	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, small stones.
655 Crippin	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.	Moderate: wetness.
733 Calco	Severe: wetness, floods.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, low strength, wetness.	Moderate: floods.
778, 778B Sattre	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: low strength.	Slight.
778C Sattre	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: low strength.	Slight.
823, 823B Ridgeport	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
823C2 Ridgeport	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Slight.
828B Zenor	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
828C, 828C2 Zenor	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Slight.
829D2*:						
Zenor	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action, low strength.	Moderate: slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
829E2*:						
Zenor	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1135 Coland	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, low strength.	Severe: floods.
1636 Buckney	Severe: cutbanks cave, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
2485B*:						
Spillville	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength, floods.	Severe: floods.
Buckney	Severe: cutbanks cave, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods.
4055*:						
Nicollet	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: frost action, low strength.	Slight.
Urban land.						
4138B*:						
Clarion	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.	Slight.
Urban land.						
4138C*:						
Clarion	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
Urban land.						
4507*:						
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
Urban land.						
5010. Pits						
5020. Dumps						
5040. Orthents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
6 Okoboji	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
27C Terril	Slight	Severe: slope.	Moderate: too clayey.	Slight	Good.
28B Dickman	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
28C Dickman	Slight	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
55 Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
62C2 Storden	Slight	Severe: slope.	Slight	Slight	Good.
62D2 Storden	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
62E2, 62F Storden	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.	Poor: slope.
73D Salida	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage, small stones.
73F Salida	Severe: slope, poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage, slope.	Poor: too sandy, seepage, small stones.
90 Okoboji	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
95 Harps	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
107 Webster	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
135 Coland	Severe: floods, wetness.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Poor: wetness.
138B Clarion	Slight	Moderate: seepage.	Slight	Slight	Good.
138C, 138C2 Clarion	Slight	Severe: slope.	Slight	Slight	Good.
138D2 Clarion	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
167----------------- Ames	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: wetness.
168B---------------- Hayden	Moderate: percs slowly.	Moderate: slope, seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
168C, 168C2--------- Hayden	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
168D2--------------- Hayden	Moderate: percs slowly, slope.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
168E---------------- Hayden	Severe: slope.	Severe: slope.	Moderate: slope, too clayey.	Severe: slope.	Poor: slope.
203----------------- Cylinder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, seepage.
221----------------- Palms	Severe: wetness, floods, subsides.	Severe: wetness, seepage, floods.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: wetness, hard to pack.
224----------------- Linder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, small stones, too sandy.
236B---------------- Lester	Moderate: percs slowly.	Moderate: slope, seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
236C2--------------- Lester	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
259----------------- Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness, seepage.	Poor: wetness, too sandy, seepage.
307----------------- Dundas	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
308, 308B----------- Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage, too sandy.
325----------------- Le Sueur	Severe: wetness.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: wetness.	Fair: too clayey, wetness.
335----------------- Harcot	Severe: wetness, poor filter.	Severe: wetness, seepage.	Severe: wetness, seepage.	Severe: wetness, seepage.	Poor: wetness, too sandy, seepage.
354----------------- Palms	Severe: wetness, floods, subsides.	Severe: wetness, seepage, floods.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: wetness, hard to pack.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
355 Luther	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness, too clayey.
356G*:					
Hayden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
383 Marna	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
385B Guckeen	Severe: percs slowly, wetness.	Moderate: slope, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey.
444C Jacwin	Severe: wetness, percs slowly, depth to rock.	Moderate: slope, depth to rock, seepage.	Severe: too clayey, depth to rock.	Moderate: wetness, depth to rock.	Poor: area reclaim, too clayey.
485 Spillville	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Fair: wetness.
485B Spillville	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage.	Severe: wetness, seepage.	Fair: wetness.
507 Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
511 Blue Earth	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, hard to pack.
536 Hanlon	Severe: floods, wetness.	Severe: floods, seepage, wetness.	Severe: floods, seepage, wetness.	Severe: floods, seepage, wetness.	Fair: wetness.
559 Talcot	Severe: wetness.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: wetness, too sandy, seepage.
566B Moingona	Moderate: percs slowly, wetness.	Moderate: slope, seepage, wetness.	Severe: wetness.	Slight	Fair: too clayey.
566C Moingona	Moderate: percs slowly, wetness.	Severe: slope.	Severe: wetness.	Slight	Fair: too clayey.
566D Moingona	Moderate: percs slowly, slope, wetness.	Severe: slope.	Severe: wetness.	Moderate: slope.	Fair: too clayey, slope.
585B*:					
Coland	Severe: floods, wetness.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Poor: wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
585B*:					
Spillville	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Fair: wetness.
636 Buckney	Severe: floods.	Severe: seepage, floods.	Severe: seepage, floods.	Severe: seepage, floods.	Poor: too sandy, seepage.
639D*:					
Storden	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
Salida	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage, small stones.
639E*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Salida	Severe: slope, poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy, slope.	Severe: seepage, slope.	Poor: too sandy, seepage, small stones.
655 Crippin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
733 Calco	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
778, 778B Sattre	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
778C Sattre	Severe: poor filter.	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
823, 823B Ridgeport	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Fair: thin layer.
823C2 Ridgeport	Severe: poor filter.	Severe: slope, seepage.	Severe: seepage, too sandy.	Severe: seepage.	Fair: thin layer.
828B Zenor	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
828C, 828C2 Zenor	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
829D2*:					
Zenor	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
Storden	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
829E2*:					
Zenor	Severe: slope, poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy, slope.	Severe: seepage, slope.	Poor: slope, too sandy, seepage.
Storden	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.	Poor: slope.
1135 Coland	Severe: floods, wetness.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Severe: floods, wetness, seepage.	Poor: wetness.
1636 Buckney	Severe: floods.	Severe: seepage, floods.	Severe: seepage, floods.	Severe: seepage, floods.	Poor: too sandy, seepage.
2485B*:					
Spillville	Severe: wetness, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Fair: wetness.
Buckney	Severe: floods.	Severe: seepage, floods.	Severe: seepage, floods.	Severe: seepage, floods.	Poor: too sandy, seepage.
4055*:					
Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Urban land.					
4138*:					
Clarion	Slight	Moderate: seepage.	Slight	Slight	Good.
Urban land.					
4138C*:					
Clarion	Slight	Severe: slope.	Slight	Slight	Good.
Urban land.					
4507*:					
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Urban land.					
5010. Pits					
5020. Dumps					
5040. Orthents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
6 Okoboji	Poor: wetness, low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
27C Terril	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
28B, 28C Dickman	Good	Fair: excess fines.	Unsuited: excess fines.	Good.
55 Nicollet	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
62C2 Storden	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: small stones.
62D2 Storden	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, small stones.
62E2, 62F Storden	Fair: slope, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
73D Salida	Good	Good	Good	Poor: small stones, area reclaim.
73F Salida	Fair: slope.	Good	Good	Poor: small stones, slope, area reclaim.
90 Okoboji	Poor: wetness, low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
95 Harps	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
107 Webster	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
135 Coland	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
138B, 138C, 138C2 Clarion	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
138D2 Clarion	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope.
167 Ames	Poor: wetness, low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
168B, 168C, 168C2 Hayden	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
168D2 Hayden	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, thin layer.
168E Hayden	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
203 Cylinder	Good	Good	Unsuited: excess fines.	Fair: area reclaim.
221 Palms	Poor: wetness, low strength.	Unsuited: excess humus, excess fines.	Unsuited: excess humus, excess fines.	Poor: wetness, excess humus.
224 Linder	Fair: wetness.	Good	Unsuited: excess fines.	Poor: small stones, area reclaim.
236B, 236C2 Lester	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
259 Biscay	Poor: wetness.	Good	Good	Fair: area reclaim.
307 Dundas	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
308, 308B Wadena	Good	Good	Unsuited: excess fines.	Good.
325 Le Sueur	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
335 Harcot	Poor: wetness.	Good	Unsuited: excess fines.	Good.
354 Palms	Poor: wetness, low strength.	Unsuited: excess humus, excess fines.	Unsuited: excess humus, excess fines.	Poor: wetness, excess humus.
355 Luther	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
356G*:				
Hayden	Poor: slope, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
Storden	Poor: slope.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
383 Marna	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
385B Guckeen	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
444C Jacwin	Poor: area reclaim, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim.
485, 485B Spillville	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
507 Canisteo	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
511 Blue Earth	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
536 Hanlon	Fair: low strength, wetness.	Poor: excess fines.	Unsuited: excess fines.	Good.
559 Talcot	Poor: wetness.	Good	Unsuited: excess fines.	Fair: area reclaim.
566B, 566C Moingona	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
566D Moingona	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope.
585B*:				
Coland	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Spillville	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
636 Buckney	Good	Fair: excess fines.	Unsuited: excess fines.	Good.
639D*:				
Storden	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, small stones.
Salida	Good	Good	Good	Poor: small stones, area reclaim.
639E*:				
Storden	Fair: slope, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
Salida	Fair: slope.	Good	Good	Poor: small stones, slope, area reclaim.
655 Crippin	Fair: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
733 Calco	Poor: wetness, shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
778, 778B, 778C Sattre	Good	Good	Unsuited: excess fines.	Fair: thin layer.
823, 823B, 823C2 Ridgeport	Good	Good	Unsuited: excess fines.	Good.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
828B, 828C, 828C2: Zenor	Good	Good	Unsuited: excess fines.	Good.
829D2*:				
Zenor	Good	Good	Unsuited: excess fines.	Fair: slope.
Storden	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, small stones.
829E2*:				
Zenor	Fair: slope.	Good	Unsuited: excess fines.	Poor: slope.
Storden	Fair: slope, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: slope.
1135: Coland	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
1636: Buckney	Good	Fair: excess fines.	Unsuited: excess fines.	Good.
2485B*:				
Spillville	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Buckney	Good	Fair: excess fines.	Unsuited: excess fines.	Good.
4055*:				
Nicollet	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Urban land.				
4138B*, 4138C*:				
Clarion	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Urban land.				
4507*:				
Canisteo	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Urban land.				
5010. Pits				
5020. Dumps				
5040. Orthents				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
6 Okoboji	Favorable	Wetness, hard to pack.	Frost action, floods.	Wetness, floods.	Wetness, erodes easily.	Wetness, erodes easily.
27C Terril	Seepage, slope.	Favorable	Not needed	Slope	Favorable	Favorable.
28B Dickman	Seepage	Seepage	Not needed	Droughty, soil blowing.	Too sandy	Droughty, slope.
28C Dickman	Seepage, slope.	Seepage	Not needed	Slope, droughty, soil blowing.	Too sandy	Droughty, slope.
55 Nicollet	Seepage	Wetness	Frost action	Wetness	Wetness	Favorable.
62C2 Storden	Slope, seepage.	Favorable	Not needed	Slope	Favorable	Erodes easily.
62D2 Storden	Slope, seepage.	Favorable	Not needed	Slope	Favorable	Slope, erodes easily.
62E2, 62F Storden	Slope, seepage.	Favorable	Not needed	Slope	Slope	Slope, erodes easily.
73D Salida	Seepage, slope.	Seepage	Not needed	Slope, droughty, fast intake.	Too sandy, slope.	Slope, droughty.
73F Salida	Seepage, slope.	Seepage	Not needed	Slope, droughty, fast intake.	Slope, too sandy.	Slope, droughty.
90 Okoboji	Favorable	Wetness, hard to pack.	Frost action, floods.	Wetness, floods.	Wetness, erodes easily.	Wetness, erodes easily.
95 Harps	Favorable	Hard to pack, wetness.	Frost action	Wetness	Wetness	Wetness.
107 Webster	Seepage	Wetness	Frost action	Wetness	Wetness	Wetness.
135 Coland	Seepage	Hard to pack, wetness.	Floods, frost action.	Wetness, floods.	Wetness	Wetness.
138B Clarion	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.
138C, 138C2 Clarion	Seepage, slope.	Favorable	Not needed	Slope	Favorable	Favorable.
138D2 Clarion	Seepage, slope.	Favorable	Not needed	Slope	Slope	Slope, erodes easily.
167 Ames	Favorable	Wetness	Frost action, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly, erodes easily.	Wetness, percs slowly, erodes easily.
168B Hayden	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.
168C, 168C2 Hayden	Slope, seepage.	Favorable	Not needed	Slope	Favorable	Favorable.
168D2 Hayden	Slope, seepage.	Favorable	Not needed	Slope	Favorable	Slope.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
168E: Hayden	Slope, seepage.	Favorable	Not needed	Slope	Slope	Slope.
203: Cylinder	Seepage	Seepage, wetness.	Not needed	Favorable	Too sandy	Favorable.
221: Palms	Seepage	Excess humus, wetness.	Floods, frost action, excess humus.	Wetness, soil blowing, floods.	Not needed	Wetness.
224: Linder	Seepage	Seepage, wetness, piping.	Not needed	Droughty	Too sandy	Droughty.
236B: Lester	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.
236C2: Lester	Slope, seepage.	Favorable	Not needed	Slope	Favorable	Favorable.
259: Biscay	Seepage	Seepage, wetness.	Frost action	Wetness	Wetness	Wetness.
307: Dundas	Seepage	Wetness, hard to pack.	Frost action	Wetness	Wetness	Wetness.
308, 308B: Wadena	Seepage	Seepage	Not needed	Favorable	Too sandy	Favorable.
325: Le Sueur	Seepage	Wetness	Frost action	Wetness	Wetness	Favorable.
335: Harcot	Seepage	Piping, seepage, wetness.	Frost action	Wetness	Wetness	Wetness.
354: Palms	Seepage	Excess humus, wetness.	Floods, frost action, excess humus.	Wetness, soil blowing, floods.	Wetness	Wetness.
355: Luther	Favorable	Wetness	Frost action	Wetness	Wetness	Favorable.
356G*:						
Hayden	Slope, seepage.	Favorable	Not needed	Slope	Slope	Slope.
Storden	Slope, seepage.	Favorable	Not needed	Slope	Slope	Slope, erodes easily.
383: Marna	Favorable	Wetness	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Percs slowly, wetness.
385B: Guckeen	Favorable	Favorable	Not needed	Percs slowly	Percs slowly	Percs slowly, erodes easily.
444C: Jacwin	Slope, depth to rock.	Thin layer, wetness, hard to pack.	Depth to rock, percs slowly, frost action.	Wetness, percs slowly, depth to rock.	Wetness, percs slowly, depth to rock.	Wetness, depth to rock.
485: Spillville	Seepage	Favorable	Not needed	Floods	Favorable	Favorable.
485B: Spillville	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
507: Canisteo	Seepage	Wetness	Frost action	Wetness	Wetness	Wetness.
511: Blue Earth	Seepage	Hard to pack, wetness, piping.	Floods, frost action.	Wetness, floods.	Wetness	Wetness.
536: Hanlon	Seepage	Seepage	Floods	Floods, soil blowing.	Favorable	Favorable.
559: Talcot	Seepage	Seepage, wetness.	Frost action	Wetness	Wetness	Wetness.
566B: Moingona	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.
566C: Moingona	Slope, seepage.	Favorable	Not needed	Slope	Favorable	Favorable.
566D: Moingona	Slope	Favorable	Not needed	Slope	Favorable	Slope.
585B*:						
Coland	Seepage	Hard to pack, wetness.	Floods, frost action.	Wetness, floods.	Wetness	Wetness.
Spillville	Seepage	Favorable	Not needed	Floods	Favorable	Favorable.
636: Buckney	Seepage	Seepage, piping.	Not needed	Soil blowing, floods.	Soil blowing	Favorable.
639D*:						
Storden	Slope, seepage.	Favorable	Not needed	Slope	Favorable	Slope, erodes easily.
Salida	Seepage, slope.	Seepage	Not needed	Slope, droughty, fast intake.	Too sandy, slope.	Slope, droughty.
639E*:						
Storden	Slope, seepage.	Favorable	Not needed	Slope	Slope	Slope, erodes easily.
Salida	Seepage, slope.	Seepage	Not needed	Slope, droughty, fast intake.	Slope, too sandy.	Slope, droughty.
655: Crippin	Seepage	Wetness	Frost action	Wetness	Wetness	Erodes easily.
733: Calco	Seepage	Hard to pack, wetness.	Floods, frost action.	Floods, wetness.	Wetness	Wetness.
778, 778B: Sattre	Seepage	Seepage	Not needed	Favorable	Too sandy	Favorable.
778C: Sattre	Slope, seepage.	Seepage	Not needed	Slope	Too sandy	Favorable.
823: Ridgeport	Seepage	Seepage	Not needed	Soil blowing	Not needed	Favorable.
823B: Ridgeport	Seepage, slope.	Seepage	Not needed	Soil blowing	Too sandy, soil blowing.	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
823C2 Ridgeport	Seepage, slope.	Seepage	Not needed	Soil blowing, slope.	Too sandy, soil blowing.	Favorable.
828B Zenor	Seepage	Seepage	Not needed	Soil blowing	Too sandy, soil blowing.	Favorable.
828C, 828C2 Zenor	Slope, seepage.	Seepage	Not needed	Soil blowing, slope.	Too sandy, soil blowing.	Favorable.
829D2*:						
Zenor	Slope, seepage.	Seepage	Not needed	Soil blowing, slope.	Too sandy, soil blowing, slope.	Slope.
Storden	Slope, seepage.	Favorable	Not needed	Slope	Favorable	Slope, erodes easily.
829E2*:						
Zenor	Slope, seepage.	Seepage	Not needed	Soil blowing, slope.	Slope, too sandy, soil blowing.	Slope.
Storden	Slope, seepage.	Favorable	Not needed	Slope	Slope	Slope, erodes easily.
1135 Coland	Seepage	Hard to pack, wetness.	Floods, frost action.	Wetness, floods.	Wetness	Wetness.
1636 Buckney	Seepage	Seepage, piping.	Not needed	Soil blowing, floods.	Soil blowing	Favorable.
2485B*:						
Spillville	Seepage	Favorable	Not needed	Floods	Favorable	Favorable.
Buckney	Seepage	Seepage, piping.	Not needed	Soil blowing, floods.	Soil blowing	Favorable.
4055*:						
Nicollet	Seepage	Wetness	Not needed	Favorable	Favorable	Favorable.
Urban land.						
4138B*:						
Clarion	Seepage	Favorable	Not needed	Favorable	Favorable	Favorable.
Urban land.						
4138C*:						
Clarion	Seepage, slope.	Favorable	Not needed	Slope	Favorable	Favorable.
Urban land.						
4507*:						
Canisteo	Seepage	Wetness	Frost action	Wetness	Wetness	Wetness.
Urban land.						
5010. Pits						
5020. Dumps						
5040. Orthents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
6----------------- Okoboji	0-32	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	32-56	Silty clay loam	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
	56-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30
27C---------------- Terril	0-28	Loam------------	CL	A-6	0-5	100	95-100	70-90	60-80	30-40	10-20
	28-61	Loam------------	CL	A-6	0-5	100	100	85-95	65-85	25-40	10-20
28B, 28C----------- Dickman	0-16	Fine sandy loam, sandy loam.	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	16-50	Sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-45	15-25	2-8
	50-60	Stratified silt to sand.	SP-SM	A-3, A-2	0	95-100	85-95	50-80	5-10	---	NP
55----------------- Nicollet	0-17	Loam------------	OL, ML, CL	A-6, A-7	0	95-100	95-100	85-98	55-85	35-50	10-25
	17-37	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-95	55-80	35-50	15-25
	37-60	Loam------------	CL, ML	A-6, A-4	0-5	95-100	90-100	75-90	50-75	30-40	5-15
62C2, 62D2, 62E2, 62F--------------- Storden	0-6	Loam------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	Loam------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
73D, 73F----------- Salida	0-8	Gravelly sandy loam.	SM, SP-SM	A-2, A-1	0-5	85-95	60-75	30-60	12-20	---	NP
	8-13	Gravelly loamy sand, gravelly coarse sand, gravelly loamy coarse sand.	SP, SW, GP, GP-GM	A-1	0-5	50-90	40-60	10-30	0-5	---	NP
	13-60	Gravelly coarse sand, gravelly loamy sand.	SP, SW, GP, GP-GM	A-1	0-5	20-70	10-60	5-30	0-5	---	NP
90----------------- Okoboji	0-9	Mucky silt loam	OH, MH	A-7	0	100	100	95-100	90-95	60-95	10-30
	9-37	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	37-60	Silty clay loam	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
95----------------- Harps	0-22	Loam------------	CL, CH	A-6, A-7	0-5	100	95-100	80-90	65-80	30-55	15-35
	22-54	Loam, clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-5	95-100	95-100	80-90	65-80	30-60	15-35
	54-60	Loam------------	CL	A-6	0-5	95-100	90-100	70-80	50-75	25-40	10-25
107---------------- Webster	0-22	Silty clay loam	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
	22-33	Clay loam, silty clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	33-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
135---------------- Coland	0-41	Clay loam--------	CL, CH	A-7	0	100	100	95-100	70-90	45-55	20-30
	41-60	Loam, clay loam.	CL, CL-ML	A-4, A-6	0	100	95-100	60-70	50-60	20-40	5-15

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
138B, 138C, 138C2, 138D2------------- Clarion	0-18	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	18-40	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	40-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
167---------------- Ames	0-17	Silt loam-------	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	50-65	25-40	5-15
	17-53	Clay loam, clay	CL	A-6, A-7	0-5	95-100	90-100	80-95	60-75	35-50	15-25
	53-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	50-65	25-40	5-15
168B, 168C, 168C2, 168D2, 168E------- Hayden	0-10	Loam------------	ML, CL-ML, CL	A-4	0	100	98-100	85-98	50-80	20-30	4-10
	10-42	Clay loam, loam	CL	A-7, A-6	0	95-100	90-98	80-95	55-75	30-50	15-26
	42-60	Loam, sandy loam, fine sandy loam.	CL, SC	A-6, A-4	0-5	95-100	90-98	75-90	35-70	20-35	8-15
203---------------- Cylinder	0-24	Loam------------	CL	A-6, A-7	0	100	90-100	80-100	50-75	30-50	10-25
	24-35	Loam, clay loam, sandy loam.	CL, SC	A-6	0	95-100	80-100	80-95	45-70	30-40	10-20
	35-60	Gravelly coarse sand, loamy coarse sand, coarse sand.	SP-SM, SM	A-1, A-2, A-3	0-10	75-95	75-95	20-55	5-25	---	NP
221---------------- Palms	0-36	Sapric material	Pt	---	---	---	---	---	---	---	---
	36-63	Clay loam, silt loam, fine sandy loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
224---------------- Linder	0-19	Sandy loam------	CL, SC	A-4, A-6	0	100	95-100	80-95	35-80	25-40	8-20
	19-31	Sandy loam------	SC, SM-SC	A-2, A-4	0	95-100	80-100	45-75	30-45	20-30	5-10
	31-60	Gravelly sand, gravelly loamy sand, loamy coarse sand.	SP, SP-SM	A-1	0-5	75-95	50-95	25-50	2-12	---	NP
236B, 236C2-------- Lester	0-13	Loam------------	ML	A-6, A-4, A-7	0	95-100	90-100	80-95	50-70	30-45	5-15
	13-32	Clay loam-------	CL	A-7, A-6	0-5	95-100	90-100	80-95	55-75	35-45	15-25
	32-60	Loam, clay loam	CL, CL-ML	A-6, A-4	0-5	95-100	90-100	75-90	50-70	20-40	5-20
259---------------- Biscay	0-17	Clay loam-------	CL, ML	A-7, A-6	0	95-100	95-100	70-90	50-75	35-50	10-25
	17-36	Loam, clay loam, sandy clay loam	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	10-20
	36-60	Stratified sand to gravel.	SP, SP-SM, GP, GP-GM	A-1	0-5	45-95	35-90	20-45	2-10	---	NP
307---------------- Dundas	0-10	Silt loam-------	ML, CL	A-6, A-4	0	100	95-98	85-97	60-80	30-40	6-16
	10-35	Clay loam, silty clay loam, sandy clay loam.	CL, CH	A-6, A-7	0-2	97-100	90-98	85-97	50-90	35-60	15-30
	35-60	Clay loam, loam, fine sandy loam.	CL, SC	A-6	0-2	95-100	90-98	80-95	35-70	30-40	10-20
308, 308B---------- Wadena	0-21	Loam------------	ML	A-4	0	95-100	80-100	75-95	50-65	25-40	2-10
	21-38	Loam, sandy loam, sandy clay loam.	SM, ML, CL-ML, SM-SC	A-4, A-6	0	95-100	80-100	75-95	40-60	25-40	5-12
	38-60	Sand and gravel	SP, SP-SM	A-1, A-3, A-2	0-5	45-100	40-95	10-80	2-10	---	NP

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
325 Le Sueur	0-8	Loam	CL	A-6	0	95-100	95-100	90-98	70-85	25-40	10-20
	8-40	Clay loam	CL, CH	A-6, A-7	0	95-100	95-100	85-98	60-80	35-60	12-30
	40-60	Loam	CL-ML, CL	A-6, A-4	0-5	95-100	90-100	80-95	55-75	20-40	5-20
335 Harcot	0-14	Loam	CH, CL, OH, OL	A-7	0	95-100	90-95	80-90	55-75	40-55	15-25
	14-34	Gravelly sandy clay loam, sandy clay loam, loam.	CL	A-6	0	90-100	90-95	75-85	55-75	30-40	10-20
	34-60	Fine sand, gravelly sand, gravelly loamy sand.	SP, SM, SP-SM	A-1	0	80-95	75-95	40-50	3-25	---	NP
354 Palms	0-35	Sapric material	Pt	---	---	---	---	---	---	---	---
	35-60	Clay loam, silty clay loam, fine sandy loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
355 Luther	0-15	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	80-95	50-65	25-40	5-15
	15-36	Clay loam	CL	A-6	0-5	95-100	90-100	75-90	50-65	25-40	15-25
	36-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	90-100	75-90	50-65	25-40	5-20
356G*:											
Hayden	0-10	Loam	ML, CL-ML, CL	A-4	0	100	98-100	85-98	50-80	20-30	4-10
	10-42	Clay loam, loam	CL	A-7, A-6	0	95-100	90-98	80-95	55-75	30-50	15-26
	42-60	Loam, sandy loam, fine sandy loam.	CL, SC	A-6, A-4	0-5	95-100	90-98	75-90	35-70	20-35	8-15
Storden	0-6	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	Loam	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
383 Marna	0-22	Silty clay loam	MH, ML	A-7	0	98-100	90-100	90-100	85-95	45-65	15-30
	22-46	Clay, silty clay, silty clay loam.	CH, MH	A-7	0	98-100	90-100	90-100	85-95	50-80	20-45
	46-60	Clay loam, loam	CL	A-7, A-6	0-5	95-100	90-98	75-95	60-80	35-50	15-25
385B Guckeen	0-18	Clay loam, silty clay loam	MH, ML, CL,	A-7	0	100	95-100	95-100	80-95	40-60	15-25
	18-36	Silty clay, silty clay loam.	MH, ML, CL	A-7	0	100	95-100	95-100	80-95	40-65	15-30
	36-60	Clay loam, loam	CL	A-6, A-7	0	90-100	90-98	85-95	60-75	30-50	10-25
444C Jacwin	0-13	Loam	OL, ML	A-7	0	100	100	90-95	50-65	40-50	10-20
	13-29	Loam, sandy clay loam, clay loam.	CL, SC	A-6	2-5	95-100	90-95	85-95	45-65	25-35	10-20
	29-33	Silty clay, clay	CL, CH	A-7	0	100	100	95-100	80-95	40-55	20-30
	33-60	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
485, 485B Spillville	0-52	Loam	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	52-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
507 Canisteo	0-18	Silty clay loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	85-100	35-50	15-25
	18-36	Clay loam, loam	CL, ML,	A-6, A-4	0-5	90-100	80-95	60-90	50-80	30-40	5-15
	36-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	60-75	30-40	12-20

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
511----------------- Blue Earth	0-22	Mucky silt loam, mucky loam.	OL, ML	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
	22-40	Loam, silty clay loam, silt loam.	OL, ML	A-5	0	95-100	80-100	80-95	80-95	41-50	2-8
	40-60	Clay loam, loam, silty clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	80-100	70-95	35-50	11-20
536----------------- Hanlon	0-43	Fine sandy loam	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
	43-60	Sandy loam, fine sandy loam, loamy fine sand.	SM-SC, SC	A-4, A-2	0	100	100	75-80	25-40	15-25	5-10
559----------------- Talcot	0-23	Clay loam--------	CL	A-7	0	100	100	80-90	60-85	40-50	15-25
	23-38	Clay loam, silty clay loam, gravelly sandy clay loam.	CL	A-7	0	95-100	85-100	70-90	60-85	40-50	15-25
	38-60	Stratified loamy sand to gravelly coarse sand.	SP, SP-SM, SW	A-1	0	65-90	50-85	20-50	2-10	---	NP
566B, 566C, 566D--- Moingona	0-12	Loam-------------	CL	A-4, A-6	0-2	95-100	95-100	80-90	50-65	25-40	8-15
	12-34	Sandy clay loam, clay loam.	CL	A-6	0-2	95-100	95-100	80-90	50-60	25-40	10-20
	34-60	Stratified sandy loam to clay loam.	CL, SC	A-4, A-6	0-2	95-100	95-100	75-90	40-55	25-40	8-15
585B*:											
Coland-------------	0-41	Clay loam--------	CL, CH	A-7	0	100	100	95-100	70-90	45-55	20-30
	41-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	100	95-100	60-70	50-60	20-40	5-15
Spillville---------	0-52	Loam-------------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	52-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
636----------------- Buckney	0-17	Fine sandy loam	SM, ML, CL-ML, SM-SC	A-2-4, A-4	0	100	100	80-95	30-60	<20	NP-7
	17-60	Sandy loam, fine sandy loam, loamy sand.	SM, ML, CL-ML, SM-SC	A-2-4, A-4	0	100	100	80-95	30-60	<20	NP-7
639D*, 639E*:											
Storden------------	0-6	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Salida-------------	0-8	Gravelly sandy loam.	SM, SP-SM	A-2, A-1	0-5	85-95	60-75	30-60	12-20	---	NP
	8-13	Gravelly loamy sand, gravelly coarse sand, gravelly loamy coarse sand.	SP, SW, GP, GP-GM	A-1	0-5	50-90	40-60	10-30	0-5	---	NP
	13-60	Gravelly coarse sand.	SP, SW, GP, GP-GM	A-1	0-5	20-70	10-60	5-30	0-5	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
655----------------- Crippin	0-18	Loam------------	CL	A-6, A-7	0	95-100	95-100	80-90	60-80	30-45	10-20
	18-30	Loam, clay loam	CL	A-6	0	95-100	90-100	80-90	60-80	30-40	10-20
	30-60	Loam, clay loam	CL, ML	A-4, A-6	0-1	90-100	85-100	75-90	55-80	30-40	5-15
733----------------- Calco	0-33	Silty clay loam, clay loam.	ML, MH, CH, CL	A-7	0	100	100	95-100	85-100	40-60	15-30
	33-60	Silty clay loam, loam, clay loam.	CL	A-7, A-6	0	100	100	90-100	80-100	30-45	10-20
778, 778B, 778C---- Sattre	0-15	Loam------------	CL, CL-ML, ML	A-4	0	100	90-100	70-90	50-75	25-35	5-10
	15-35	Loam, sandy clay loam, clay loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0-5	85-95	80-95	70-85	40-60	20-35	5-15
	35-60	Gravelly coarse sand, sand, loamy sand.	SW, SM, SP, SP-SM	A-1	2-10	60-85	50-70	20-40	3-25	---	NP
823, 823B, 823C2--- Ridgeport	0-14	Sandy loam------	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	70-90	25-50	15-30	2-10
	14-32	Sandy loam, gravelly sandy loam.	SM, SC, SM-SC	A-2, A-4	0	95-100	85-100	65-85	20-45	15-30	2-10
	32-60	Loamy sand, gravelly sand, sand.	SW, SP, SM, SM-SC	A-1, A-2	0-5	80-95	75-95	35-60	2-15	<25	NP-8
828B, 828C, 828C2-- Zenor	0-12	Sandy loam------	SM-SC, SC	A-2, A-4	0	95-100	90-95	60-70	25-40	15-25	5-10
	12-33	Sandy loam, loam	SM-SC, SC	A-2, A-4	0	95-100	90-95	50-70	25-40	15-25	5-10
	33-60	Gravelly loamy sand, sand, loamy sand.	SW, SP, SP-SM	A-1-B	0-5	70-90	70-85	20-40	3-12	<20	NP-5
829D2*, 829E2*: Zenor-------------	0-12	Sandy loam------	SM-SC, SC	A-2, A-4	0	95-100	90-95	60-70	25-40	15-25	5-10
	12-33	Sandy loam, loam	SM-SC, SC	A-2, A-4	0	95-100	90-95	50-70	25-40	15-25	5-10
	33-60	Gravelly loamy sand, gravelly sand.	SW, SP, SP-SM	A-1-B	0-5	70-90	70-85	20-40	3-12	<20	NP-5
Storden-----------	0-6	Loam------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	Loam------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
1135---------------- Coland	0-41	Clay loam-------	CL, CH	A-7	0	100	100	95-100	70-90	45-55	20-30
	41-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	100	95-100	60-70	50-60	20-40	5-15
1636---------------- Buckney	0-17	Fine sandy loam	SM, ML, CL-ML, SM-SC	A-2-4, A-4	0	100	100	80-95	30-60	<20	NP-7
	17-60	Sandy loam, fine sandy loam, very fine sandy loam, loamy sand.	SM, ML, CL-ML, SM-SC	A-2-4, A-4	0	100	100	80-95	30-60	<20	NP-7
2485B*: Spillville--------	0-52	Loam------------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	52-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
2485B*:											
Buckney-----------	0-17	Fine sandy loam	SM, ML, CL-ML, SM-SC	A-2-4, A-4	0	100	100	80-95	30-60	<20	NP-7
	17-60	Sandy loam, fine sandy loam, very fine sandy loam.	SM, ML, CL-ML, SM-SC	A-2-4, A-4	0	100	100	80-95	30-60	<20	NP-7
4055*:											
Nicollet----------	0-17	Loam------------	OL, ML, CL	A-6, A-7	0	95-100	95-100	85-98	55-85	35-50	10-25
	17-37	Clay loam, loam	CL	A-6, A-7	0-5	95-100	95-100	80-95	55-80	35-50	15-25
	37-60	Loam------------	CL, ML	A-6, A-4	0-5	95-100	90-100	75-90	50-75	30-40	5-15
Urban land.											
4138B*, 4138C*:											
Clarion-----------	0-18	Loam------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	18-40	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	40-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Urban land.											
4507*:											
Canisteo----------	0-18	Silty clay loam	CL	A-7, A-6	0	100	100	90-100	85-100	35-50	15-25
	18-36	Clay loam, loam	CL, ML	A-6, A-4	0-5	90-100	80-95	60-90	50-80	30-40	5-15
	36-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	60-75	30-40	12-20
Urban land.											
5010. Pits											
5020. Dumps											
5040. Orthents											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permeability	Available water capacity	Reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
6----------------- Okoboji	0-32	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.6-7.8	High----------	0.37	5	4	6-8
	32-56	30-38	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High----------	0.37			
	56-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate------	0.28			
27C--------------- Terril	0-28	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.24	5	6	4-5
	28-61	27-32	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low-----------	0.32			
28B, 28C---------- Dickman	0-16	12-18	1.50-1.55	2.0-6.0	0.13-0.15	6.1-6.5	Low-----------	0.20	3	3	2-4
	16-50	10-15	1.55-1.65	2.0-20	0.12-0.14	5.6-6.5	Low-----------	0.20			
	50-60	5-10	1.60-1.70	6.0-20	0.02-0.07	5.6-7.3	Low-----------	0.15			
55---------------- Nicollet	0-17	24-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate------	0.24	5	6	4-5
	17-37	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate------	0.32			
	37-60	22-28	1.35-1.45	0.6-2.0	0.14-0.19	7.4-7.8	Low-----------	0.32			
62C2, 62D2, 62E2, 62F-------------- Storden	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	5	4L	<1-2
	6-60	18-27	1.30-1.45	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
73D, 73F---------- Salida	0-8	5-15	1.35-1.45	2.0-6.0	0.10-0.12	6.1-8.4	Low-----------	0.10	3	8	1-2
	8-13	2-8	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low-----------	0.10			
	13-60	0-5	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low-----------	0.10			
90---------------- Okoboji	0-9	20-26	1.20-1.25	0.6-2.0	0.24-0.26	6.6-7.8	High----------	0.37	5	4	8-16
	9-37	32-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High----------	0.37			
	37-60	30-38	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High----------	0.37			
95---------------- Harps	0-22	25-35	1.35-1.40	0.6-2.0	0.19-0.21	7.9-8.4	Moderate------	0.24	5	4L	6-7
	22-54	26-32	1.40-1.50	0.6-2.0	0.17-0.19	7.9-8.4	Moderate------	0.32			
	54-60	20-26	1.50-1.70	0.6-2.0	0.17-0.19	7.9-8.4	Moderate------	0.32			
107--------------- Webster	0-22	30-36	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	Moderate------	0.24	5	6	6-8
	22-33	28-34	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate------	0.32			
	33-60	23-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate------	0.32			
135--------------- Coland	0-41	27-32	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High----------	0.28	5	7	6-8
	41-60	12-26	1.50-1.65	2.0-6.0	0.13-0.17	6.1-7.3	Low-----------	0.28			
138B, 138C, 138C2, 138D2---- Clarion	0-18	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low-----------	0.28	5	6	3-4
	18-40	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low-----------	0.37			
	40-60	12-22	1.70-1.80	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
167--------------- Ames	0-17	16-22	1.40-1.45	0.6-2.0	0.21-0.23	5.6-7.3	Moderate------	0.37	5	6	<1
	17-40	35-42	1.45-1.65	<0.06	0.15-0.17	5.1-6.0	High----------	0.37			
	40-60	25-30	1.65-1.80	0.6-2.0	0.16-0.18	6.6-8.4	Moderate------	0.37			
168B, 168C, 168C2, 168D2, 168E------------ Hayden	0-10	10-25	1.40-1.60	0.6-2.0	0.20-0.22	5.6-7.3	Low-----------	0.32	5	6	<1-2
	10-42	18-35	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate------	0.32			
	42-60	15-27	1.65-1.80	0.6-2.0	0.14-0.19	7.4-8.4	Low-----------	0.32			
203--------------- Cylinder	0-24	22-32	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate------	0.24	4	6	4-5
	24-35	22-30	1.45-1.60	0.6-2.0	0.17-0.19	6.1-7.3	Moderate------	0.32			
	35-60	2-12	1.60-1.70	6.0-20	0.02-0.04	7.4-8.4	Low-----------	0.10			
221--------------- Palms	0-36	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-8.4	--------------	----	---	3	20-40
	36-63	7-35	1.46-2.00	0.2-2.0	0.14-0.22	6.1-8.4	Low-----------	----			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permeability	Available water capacity	Reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
224------------- Linder	0-19	14-20	1.40-1.45	2.0-6.0	0.20-0.22	5.6-7.8	Low----------	0.24	4	6	4-5
	19-31	10-14	1.45-1.55	2.0-6.0	0.15-0.17	6.1-7.8	Low----------	0.24			
	31-60	2-8	1.55-1.75	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.10			
236B, 236C2------ Lester	0-13	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-6.5	Low----------	0.28	5	6	1-3
	13-48	24-30	1.50-1.70	0.6-2.0	0.15-0.19	5.1-6.5	Moderate-----	0.28			
	48-60	20-26	1.70-1.80	0.6-2.0	0.14-0.19	6.6-7.8	Low----------	0.37			
259------------- Biscay	0-17	18-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.28	4	6	6-8
	17-36	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.28			
	36-60	1-6	1.55-1.65	6.0-20	0.02-0.04	6.6-8.4	Low----------	0.10			
307------------- Dundas	0-10	10-27	1.40-1.60	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.28	5	6	2-3
	10-35	20-35	1.50-1.65	0.2-0.6	0.15-0.19	5.1-7.3	Moderate-----	0.28			
	35-60	15-30	1.60-1.75	0.6-2.0	0.14-0.19	7.4-8.4	Moderate-----	0.28			
308, 308B-------- Wadena	0-21	18-28	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5	2-3
	21-38	18-30	1.35-1.50	0.6-2.0	0.14-0.19	6.1-7.3	Low----------	0.32			
	38-60	1-5	1.55-1.65	>6.0	0.02-0.04	6.6-8.4	Low----------	0.10			
325------------- Le Sueur	0-8	24-35	1.15-1.25	0.6-2.0	0.17-0.19	5.6-7.3	Moderate-----	0.24	5	6	2-4
	8-40	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.32			
	40-60	22-28	1.35-1.45	0.6-2.0	0.14-0.16	7.4-8.4	Moderate-----	0.32			
335------------- Harcot	0-20	24-29	1.35-1.40	0.6-2.0	0.20-0.22	7.9-8.4	Moderate-----	0.28	4	6	6-7
	20-33	18-30	1.40-1.60	0.6-2.0	0.17-0.19	7.9-8.4	Moderate-----	0.28			
	33-60	2-8	1.60-1.75	>20	0.05-0.07	6.6-7.8	Low----------	0.15			
354------------- Palms	0-35	---	0.25-0.45	0.2-6.0	0.35-0.45	5.1-8.4	-------------	----	---	3	40-90
	35-60	7-35	1.46-2.00	0.2-2.0	0.14-0.22	6.1-8.4	Low----------	----			
355------------- Luther	0-15	24-35	1.15-1.25	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.32	5	6	2-3
	15-36	24-35	1.25-1.35	0.2-0.6	0.16-0.18	5.6-7.8	High---------	0.32			
	36-60	22-28	1.35-1.45	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32			
356G*:											
Hayden----------	0-10	10-25	1.40-1.60	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.32	5	6	1-2
	10-42	18-35	1.50-1.65	0.6-2.0	0.15-0.19	5.1-7.3	Moderate-----	0.32			
	42-60	15-27	1.65-1.80	0.6-2.0	0.14-0.19	7.4-8.4	Low----------	0.32			
Storden---------	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L	1-2
	6-60	18-27	1.30-1.45	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
383------------- Marna	0-22	30-50	1.20-1.30	0.06-0.2	0.18-0.22	6.1-7.3	High---------	0.28	5	4	6-8
	22-46	40-60	1.25-1.40	0.06-0.2	0.13-0.16	6.1-7.3	High---------	0.28			
	46-60	24-40	1.35-1.50	0.2-2.0	0.14-0.19	6.6-8.4	Moderate-----	0.28			
385B------------ Guckeen	0-18	35-50	1.20-1.30	0.2-0.6	0.16-0.19	5.6-7.3	Moderate-----	0.28	3	7	4-6
	18-36	35-50	1.25-1.35	0.06-0.6	0.13-0.16	5.6-7.3	Moderate-----	0.28			
	36-60	24-40	1.35-1.55	0.2-0.6	0.15-0.17	6.6-8.4	Moderate-----	0.37			
444C------------ Jacwin	0-13	22-34	1.35-1.45	0.6-2.0	0.20-0.22	6.6-7.3	Moderate-----	0.28	5	6	3-4
	13-29	24-34	1.50-1.60	0.6-2.0	0.17-0.19	6.6-7.3	Low----------	0.28			
	29-33	40-60	1.70-1.80	<0.06	0.12-0.14	7.4-8.4	Moderate-----	0.28			
	33-60	---	1.80-1.90	---	---	---	-------------	----			
485, 485B-------- Spillville	0-52	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6	4-5
	52-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28			
507------------- Canisteo	0-18	18-35	1.20-1.30	0.6-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.32	5	4L	6-8
	18-38	10-35	1.30-1.50	0.6-6.0	0.12-0.18	7.4-8.4	Low----------	0.32			
	38-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low----------	0.32			
511------------- Blue Earth	0-22	18-32	0.30-1.00	0.6-6.0	0.18-0.24	7.4-8.4	Moderate-----	0.28	5	5	20-40
	22-40	18-32	0.30-1.00	0.6-2.0	0.18-0.24	7.4-8.4	Low----------	0.28			
	40-65	18-32	1.30-1.40	0.2-2.0	0.14-0.16	7.4-8.4	Moderate-----	0.28			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permeability	Available water capacity	Reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
536------------- Hanlon	0-43	12-15	1.50-1.70	2.0-6.0	0.16-0.18	6.6-7.3	Low----------	0.20	5	3	3-4
	43-60	5-10	1.70-1.75	2.0-6.0	0.11-0.13	5.6-7.3	Low----------	0.20			
559------------- Talcot	0-23	27-35	1.20-1.30	0.6-2.0	0.18-0.22	7.4-8.4	Moderate-----	0.28	4	7	6-8
	23-38	25-35	1.25-1.35	0.6-2.0	0.17-0.20	7.4-8.4	Moderate-----	0.28			
	38-60	1-6	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	Low----------	0.15			
566B, 566C, 566D- Moingona	0-12	18-20	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.28	5	5	2-4
	12-34	21-35	1.45-1.65	0.6-2.0	0.16-0.18	5.6-7.3	Moderate-----	0.28			
	34-60	15-30	1.65-1.75	0.6-2.0	0.16-0.18	5.6-8.4	Low----------	0.28			
585B*:											
Coland----------	0-41	27-32	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28	5	7	6-8
	41-60	12-26	1.50-1.65	2.0-6.0	0.13-0.17	6.1-7.3	Low----------	0.28			
Spillville------	0-52	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6	4-5
	52-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28			
636------------- Buckney	0-17	12-18	1.2-1.5	2.0-6.0	0.12-0.18	6.6-7.8	Low----------	0.17	4	3	2-4
	17-60	12-18	1.2-1.5	2.0-6.0	0.12-0.18	6.6-7.8	Low----------	0.17			
639D*, 639E*:											
Storden---------	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L	1-2
	6-60	18-27	1.30-1.45	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
Salida----------	0-8	5-15	1.35-1.45	2.0-6.0	0.10-0.12	6.1-8.4	Low----------	0.10	3	8	1-2
	8-13	2-8	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low----------	0.10			
	13-60	0-5	1.50-1.65	>20	0.02-0.04	7.4-8.4	Low----------	0.10			
655------------- Crippin	0-18	22-28	1.35-1.40	0.6-2.0	0.20-0.22	6.6-8.4	Moderate-----	0.28	5	6	4-6
	18-30	24-30	1.40-1.55	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.28			
	30-60	22-28	1.55-1.75	0.6-2.0	0.17-0.19	7.9-8.4	Moderate-----	0.37			
733------------- Calco	0-33	28-33	1.25-1.30	0.2-0.6	0.21-0.23	7.4-8.4	High---------	0.28	5	7	6-8
	33-60	22-32	1.30-1.45	0.6-2.0	0.18-0.20	7.4-8.4	Moderate-----	0.28			
778, 778B, 778C-- Sattre	0-15	18-24	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Low----------	0.28	4	6	2-4
	15-35	18-28	1.40-1.50	0.6-6.0	0.15-0.17	5.1-5.5	Low----------	0.28			
	35-60	2-8	1.50-1.75	>20	0.02-0.06	5.1-5.5	Low----------	0.15			
823, 823B, 823C2- Ridgeport	0-14	10-18	1.50-1.55	2.0-6.0	0.14-0.17	5.6-7.3	Low----------	0.24	4	3	2-4
	14-32	10-18	1.55-1.60	2.0-6.0	0.10-0.14	5.6-7.3	Low----------	0.24			
	32-60	2-10	1.60-1.75	>6.0	0.03-0.05	7.4-8.4	Low----------	0.10			
828B, 828C, 828C2----------- Zenor	0-12	12-20	1.50-1.55	2.0-6.0	0.14-0.16	5.6-7.3	Low----------	0.20	4	3	2-3
	12-33	12-20	1.55-1.60	2.0-6.0	0.13-0.15	6.1-8.4	Low----------	0.20			
	33-60	2-8	1.60-1.75	6.0-20	0.06-0.09	7.9-8.4	Very low-----	0.10			
829D2*, 829E2*:											
Zenor-----------	0-12	12-20	1.50-1.55	2.0-6.0	0.14-0.16	5.6-7.3	Low----------	0.20	4	3	1-2
	12-33	12-20	1.55-1.60	2.0-6.0	0.13-0.15	6.1-8.4	Low----------	0.20			
	33-60	2-8	1.60-1.75	6.0-20	0.06-0.09	7.9-8.4	Very low-----	0.10			
Storden---------	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L	<1
	6-60	18-27	1.30-1.45	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
1135------------ Coland	0-41	27-32	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High---------	0.28	5	7	6-8
	41-60	12-26	1.50-1.65	2.0-6.0	0.13-0.17	6.1-7.3	Low----------	0.28			
1636------------ Buckney	0-17	12-18	1.2-1.5	2.0-6.0	0.12-0.18	6.6-7.8	Low----------	0.17	4	3	3-4
	17-60	12-18	1.2-1.5	2.0-6.0	0.12-0.18	6.6-7.8	Low----------	0.17			
2485B*:											
Spillville------	0-52	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6	4-5
	52-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permeability	Available water capacity	Reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
2485B*:											
Buckney----------	0-17	12-18	1.2-1.5	2.0-6.0	0.12-0.18	6.6-7.8	Low-----------	0.17	4	3	1-3
	17-60	12-18	1.2-1.5	2.0-6.0	0.12-0.18	6.6-7.8	Low-----------	0.17			
4055*:											
Nicollet---------	0-17	24-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate------	0.24	5	6	4-8
	17-37	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate------	0.32			
	37-60	22-28	1.35-1.45	0.6-2.0	0.14-0.19	7.4-7.8	Low-----------	0.32			
Urban land.											
4138B*, 4138C*:											
Clarion----------	0-18	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low-----------	0.28	5	6	3-4
	18-40	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low-----------	0.37			
	40-60	12-22	1.70-1.80	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
Urban land.											
4507*:											
Canisteo---------	0-18	18-35	1.20-1.30	0.6-2.0	0.20-0.22	7.4-8.4	Moderate------	0.32	5	4L	4-8
	18-36	10-35	1.30-1.50	0.6-6.0	0.12-0.18	7.4-8.4	Low-----------	0.32			
	36-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low-----------	0.32			
Urban land.											
5010. Pits											
5020. Dumps											
5040. Orthents											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
6----------------- Okoboji	B/D	Occasional	Long------	Feb-Nov	0-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
27C--------------- Terril	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
28B, 28C---------- Dickman	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Moderate.
55---------------- Nicollet	B	None--------	---	---	2.5-5.0	Apparent	Apr-May	>60	---	High-----	High-----	Low.
62C2, 62D2, 62E2, 62F-------------- Storden	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
73D, 73F---------- Salida	A	None--------	---	---	>6.0	---	---	>60	---	Low------	Low------	Low.
90---------------- Okoboji	B/D	Frequent----	Long------	Feb-Nov	0-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
95---------------- Harps	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	High-----	High-----	Low.
107--------------- Webster	B/D	None--------	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
135--------------- Coland	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
138B, 138C, 138C2, 138D2------------ Clarion	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
167--------------- Ames	C/D	None--------	---	---	0-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
168B, 168C, 168C2, 168D2, 168E------ Hayden	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
203--------------- Cylinder	B	None--------	---	---	3.0-5.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Low.
221--------------- Palms	A/D	Frequent----	Long------	Nov-May	0-1.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
224--------------- Linder	B	None--------	---	---	1.5-3.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
236B, 236C2: Lester	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Moderate.
259: Biscay	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	High	Moderate	Low.
307: Dundas	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	High	High	Moderate.
308, 308B: Wadena	B	None	---	---	>6.0	---	---	>60	---	Low	Low	Low.
325: Le Sueur	B	None	---	---	2.0-5.0	Perched	Nov-May	>60	---	High	High	Low.
335: Harcot	B/D	Rare	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Low.
354: Palms	A/D	Frequent	Long	Nov-May	0-1.0	Apparent	Nov-May	>60	---	High	High	Moderate.
355: Luther	B	None	---	---	1.5-3.0	Apparent	Nov-Jul	>60	---	High	High	Moderate.
356C*:												
Hayden	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Moderate.
Storden	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
383: Marna	D	None	---	---	0-2.5	Apparent	Nov-Jun	>60	---	High	High	Low.
385B: Guckeen	C	None	---	---	3.5-5.0	Apparent	Apr-May	>60	---	High	High	Low.
444C: Jacwin	B	None	---	---	2.0-4.0	Perched	Nov-Jun	40-60	Rippable	High	High	Low.
485: Spillville	B	Frequent	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	High	Moderate.
485B: Spillville	B	None	---	---	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	High	Moderate.
507: Canisteo	C/D	None	---	---	1.0-3.0	Apparent	Oct-Jul	>60	---	High	High	Low.
511: Blue Earth	B/D	Frequent	Brief	Apr-Jun	0-1.0	Apparent	Nov-Jun	>60	---	High	High	Low.
536: Hanlon	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jun	>60	---	Moderate	Moderate	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In				
559----------------- Talcot	B/D	None---------	---	---	1.0-3.0	Apparent	Oct-Jul	>60	---	High------	High------	Low.
566B, 566C, 566D-- Moingona	C	None---------	---	---	4.0-6.0	Apparent	Nov-Jun	>60	---	Moderate	High------	Low.
585B*:												
Coland------------	B/D	Occasional	Brief------	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
Spillville--------	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	High------	Moderate.
636----------------- Buckney	B	Frequent----	Brief------	Apr-Jun	>6.0	---	---	>60	---	Moderate	Low-------	Low.
639D*, 639E*:												
Storden-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low-------	Low.
Salida------------	A	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Low.
655----------------- Crippin	B	None---------	---	---	1.5-3.0	Apparent	Nov-Jun	>60	---	High------	High------	Low.
733----------------- Calco	B/D	Occasional	Brief------	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
778, 778B, 778C--- Sattre	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	High.
823, 823B, 823C2-- Ridgeport	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Low.
828B, 828C, 828C2- Zenor	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Low.
829D2*, 829E2*:												
Zenor-------------	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Low.
Storden-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low-------	Low.
1135---------------- Coland	B/D	Frequent----	Brief------	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
1636---------------- Buckney	B	Frequent----	Brief------	Apr-Jun	>6.0	---	---	>60	---	Moderate	Low-------	Low.
2485B*:												
Spillville--------	B	Frequent----	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	High------	Moderate.
Buckney-----------	B	Frequent----	Brief------	Apr-Jun	>6.0	---	---	>60	---	Moderate	Low-------	Low.
4055*:												
Nicollet----------	B	None---------	---	---	2.5-5.0	Apparent	Apr-May	>60	---	High------	High------	Low.
Urban land.												

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
4138B*, 4138C*:												
Clarion----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
Urban land.												
4507*:												
Canisteo---------	C/D	None--------	---	---	1.0-3.0	Apparent	Oct-Jul	>60	---	High-----	High-----	Low.
Urban land.												
5010. Pits												
5020. Dumps												
5040. Orthents												

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

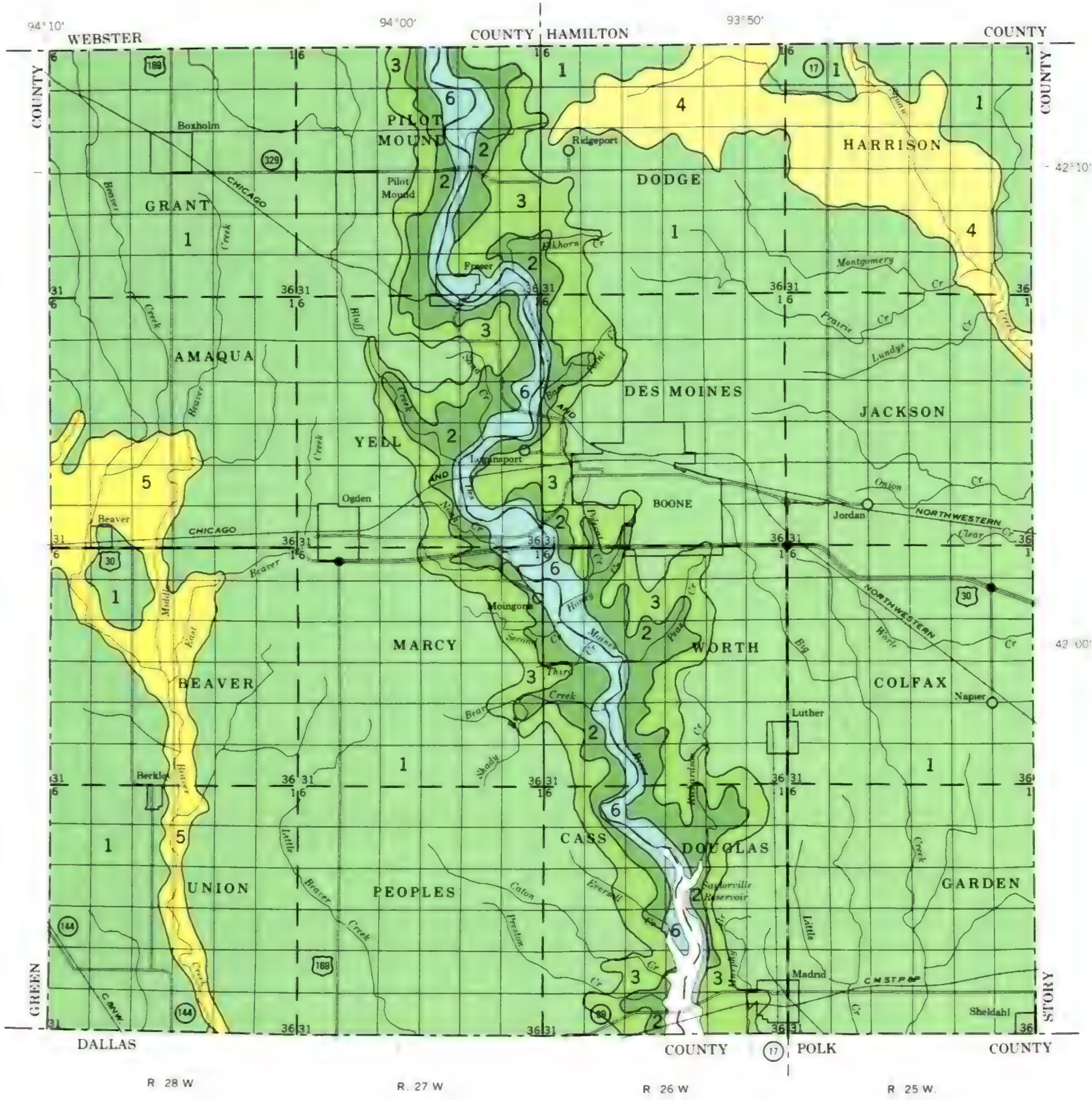
Soil name	Family or higher taxonomic class
Ames	Fine, montmorillonitic, mesic Typic Albaqualfs
Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
*Blue Earth	Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents
Buckney	Coarse-loamy, mixed, mesic Entic Hapludolls
*Calco	Fine-silty, mixed (calcareous), mesic Cumulic Haplaquolls
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Clarion	Fine-loamy, mixed, mesic Typic Hapludolls
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Crippin	Fine-loamy, mixed, mesic Aquic Hapludolls
Cylinder	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Aquic Hapludolls
Dickman	Sandy, mixed, mesic Typic Hapludolls
Dundas	Fine-loamy, mixed, mesic Udollic Ochraqualfs
Guckeen	Fine, montmorillonitic, mesic Aquic Hapludolls
Hanlon	Coarse-loamy, mixed, mesic Cumulic Hapludolls
Harcot	Fine-loamy over sandy or sandy-skeletal, mesic Typic Calciaquolls
Harps	Fine-loamy, mesic Typic Calciaquolls
Hayden	Fine-loamy, mixed, mesic Typic Hapludalfs
Jacwin	Fine-loamy over clayey, mixed, mesic Aquic Hapludolls
Le Sueur	Fine-loamy, mixed, mesic Aquic Argiudolls
Lester	Fine-loamy, mixed, mesic Mollic Hapludalfs
Linder	Coarse-loamy, mixed, mesic Aquic Hapludolls
Luther	Fine-loamy, mixed, mesic Aeric Ochraqualfs
Marna	Fine, montmorillonitic, mesic Typic Haplaquolls
Moingona	Fine-loamy, mixed, mesic Typic Argiudolls
Nicollet	Fine-loamy, mixed, mesic Aquic Hapludolls
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Orthents	Loamy, mixed, mesic Udorthents
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Ridgeport	Coarse-loamy, mixed, mesic Typic Hapludolls
*Salida	Sandy-skeletal, mixed, mesic Entic Hapludolls
Sattre	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Mollic Hapludalfs
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Talcot	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
*Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
Zenor	Coarse-loamy, mixed, mesic Typic Hapludolls

*The soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1981 -326-445/68

NRCS Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION
COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY
DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

GENERAL SOIL MAP

BOONE COUNTY, IOWA

Scale 1:190,080

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

SOIL LEGEND*

1 — Canisteo-Clarion-Nicollet association. Nearly level to moderately sloping, poorly drained, well drained and somewhat poorly drained, loamy soils on uplands

2 — Hayden-Storden association. Very steep, well drained, loamy soils on uplands

3 — Hayden-Lester-Luther association. Nearly level to moderately sloping, well drained and somewhat poorly drained, loamy soils on uplands

4 — Clarion-Zenor association. Gently sloping to strongly sloping, well drained and somewhat excessively drained, loamy soils on uplands

5 — Coland-Talcot-Wadena association. Nearly level and gently sloping, poorly drained and well drained loamy soils on bottom lands and stream benches

6 — Buckney-Moingona-Sattre association. Nearly level to moderately sloping, excessively drained, moderately well drained, and well drained, loamy soils on bottom lands, alluvial fans, foot slopes, and stream benches

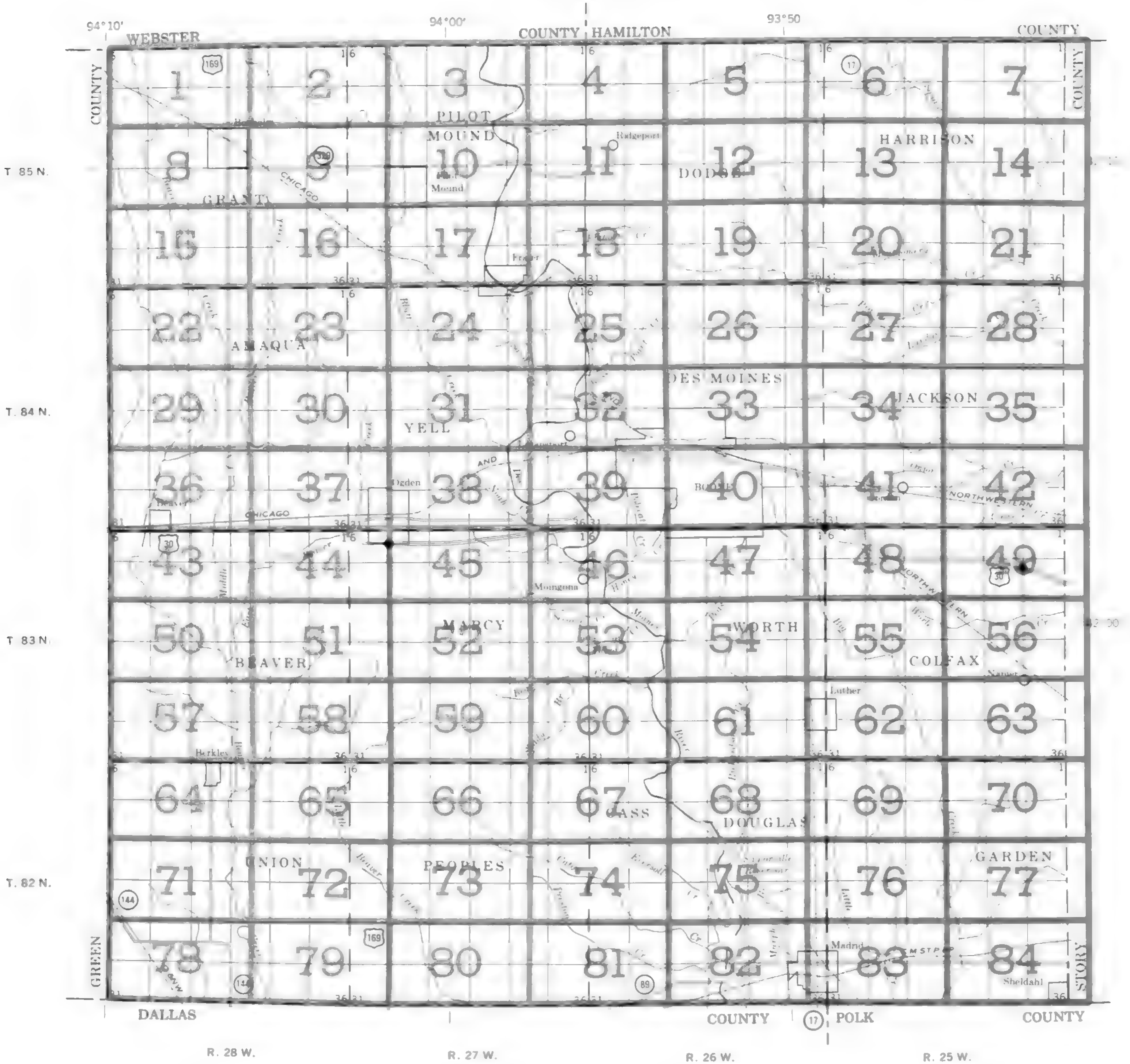
*The texture given in the descriptive heading refers to the texture of the surface layer of the major soils in each association

Compiled 1979

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

BOONE COUNTY, IOWA

Scale 1:190,080

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

Original text from each individual map sheet read:
This map is compiled on 1976 aerial photography by the U.S. Department of Agriculture. Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and letters. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas. A final number of 2 following the slope letter indicates that the soil is moderately eroded.

SYMBOL	NAME
6	Okoboji silty clay loam, 0 to 1 percent slopes
27C	Terril loam, 5 to 9 percent slopes
28B	Dickman fine sandy loam, 1 to 5 percent slopes
28C	Dickman fine sandy loam, 5 to 9 percent slopes
55	Nicollet loam, 1 to 3 percent slopes
62C2	Storden loam, 5 to 9 percent slopes, moderately eroded
62D2	Storden loam, 9 to 14 percent slopes, moderately eroded
62E2	Storden loam, 14 to 18 percent slopes, moderately eroded
62F	Storden loam, 18 to 25 percent slopes
73D	Salida gravelly sandy loam, 5 to 14 percent slopes
73F	Salida gravelly sandy loam, 14 to 25 percent slopes
90	Okoboji mucky silt loam, 0 to 1 percent slopes
95	Harps loam, 0 to 2 percent slopes
107	Webster silty clay loam, 0 to 2 percent slopes
135	Coland clay loam, 0 to 2 percent slopes
138B	Clarion loam, 2 to 5 percent slopes
138C	Clarion loam, 5 to 9 percent slopes
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded
138D2	Clarion loam, 9 to 14 percent slopes, moderately eroded
167	Ames silt loam, 0 to 1 percent slopes
168B	Hayden loam, 2 to 5 percent slopes
168C	Hayden loam, 5 to 9 percent slopes
168C2	Hayden loam, 5 to 9 percent slopes, moderately eroded
168D2	Hayden loam, 9 to 14 percent slopes, moderately eroded
168E	Hayden loam, 14 to 18 percent slopes
203	Cylinder loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
221	Palms muck, 0 to 1 percent slopes
224	Linder sandy loam, 0 to 2 percent slopes
236B	Lester loam, 2 to 5 percent slopes
236C2	Lester loam, 5 to 9 percent slopes, moderately eroded
259	Biscay clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
307	Dundas silt loam, 0 to 2 percent slopes
308	Wadena loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
308B	Wadena loam, 32 to 40 inches to sand and gravel, 2 to 5 percent slopes
325	Le Sueur loam, 0 to 2 percent slopes
335	Harcot loam, 0 to 2 percent slopes
354	Palms muck, ponded, 0 to 1 percent slopes
355	Luther loam, 0 to 2 percent slopes
356G	Hayden–Storden loams, 25 to 50 percent slopes

SYMBOL	NAME
383	Marna silty clay loam, 0 to 2 percent slopes
385B	Guckeen clay loam, 1 to 4 percent slopes
444C	Jacwin loam, 3 to 9 percent slopes
485	Spillville loam, 0 to 2 percent slopes
485B	Spillville loam, 2 to 5 percent slopes
507	Canisteo silty clay loam, 0 to 2 percent slopes
511	Blue Earth mucky silt loam, 0 to 1 percent slopes
536	Hanlon fine sandy loam, 0 to 2 percent slopes
559	Talcot clay loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
566B	Moingona loam, 1 to 5 percent slopes
566C	Moingona loam, 5 to 9 percent slopes
566D	Moingona loam, 9 to 14 percent slopes
585B	Coland–Spillville complex, 2 to 5 percent slopes
636	Buckney fine sandy loam, 1 to 3 percent slopes
639D	Storden–Salida complex, 9 to 14 percent slopes
639E	Storden–Salida complex, 14 to 25 percent slopes
655	Crippin loam, 1 to 3 percent slopes
733	Calco silty clay loam, 0 to 2 percent slopes
778	Sattre loam, 0 to 2 percent slopes
778B	Sattre loam, 2 to 5 percent slopes
778C	Sattre loam, 5 to 9 percent slopes
823	Ridgeport sandy loam, 0 to 2 percent slopes
823B	Ridgeport sandy loam, 2 to 5 percent slopes
823C2	Ridgeport sandy loam, 5 to 9 percent slopes, moderately eroded
828B	Zenor sandy loam, 2 to 5 percent slopes
828C	Zenor sandy loam, 5 to 9 percent slopes
828C2	Zenor sandy loam, 5 to 9 percent slopes, moderately eroded
829D2	Zenor–Storden complex, 9 to 14 percent slopes, moderately eroded
829E2	Zenor–Storden complex, 14 to 25 percent slopes, moderately eroded
1135	Coland clay loam, channeled, 0 to 2 percent slopes
1636	Buckney fine sandy loam, channeled, 0 to 2 percent slopes
2485B	Spillville–Buckney complex, 2 to 5 percent slopes
4055	Nicollet–Urban land complex, 1 to 3 percent slopes
4138B	Clarion–Urban land complex, 2 to 5 percent slopes
4138C	Clarion–Urban land complex, 5 to 9 percent slopes
4507	Canisteo–Urban land complex, 0 to 2 percent slopes
5010	Pits, gravel
5020	Dumps, mine
5040	Orthents, loamy

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

Davis Airstrip

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water
- Intermittent — int

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 138B 507

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

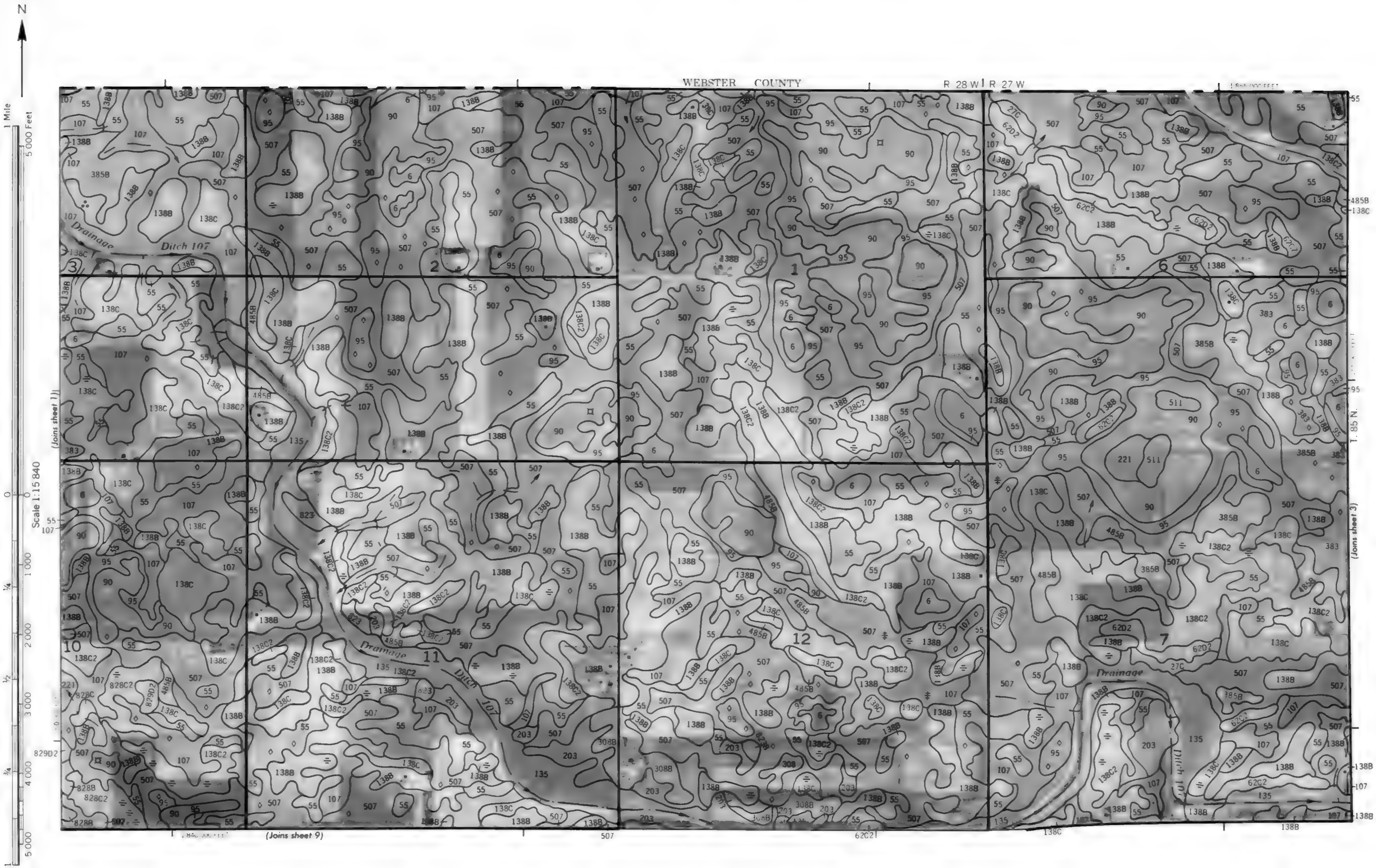
DEPRESSION OR SINK

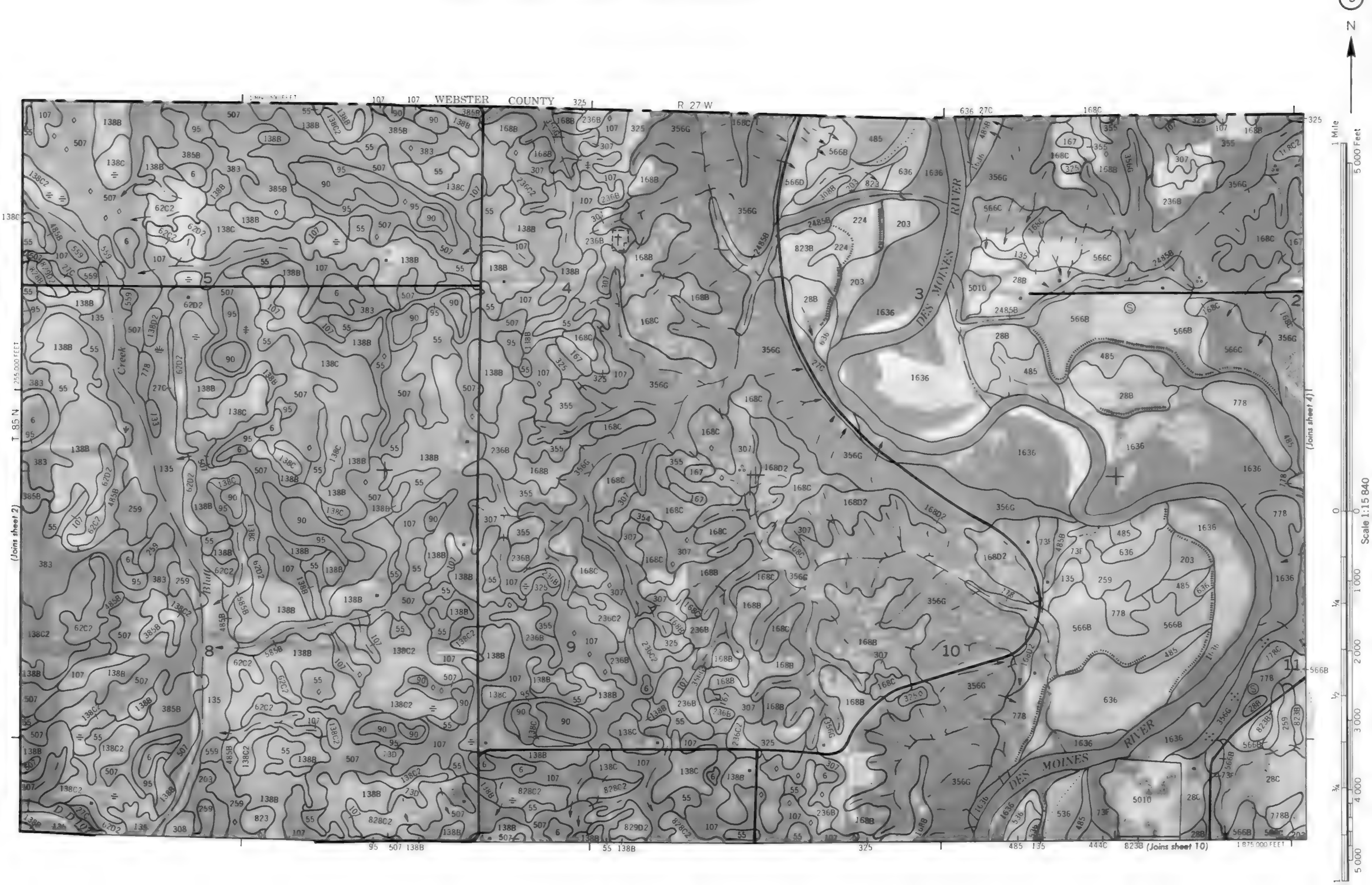
SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

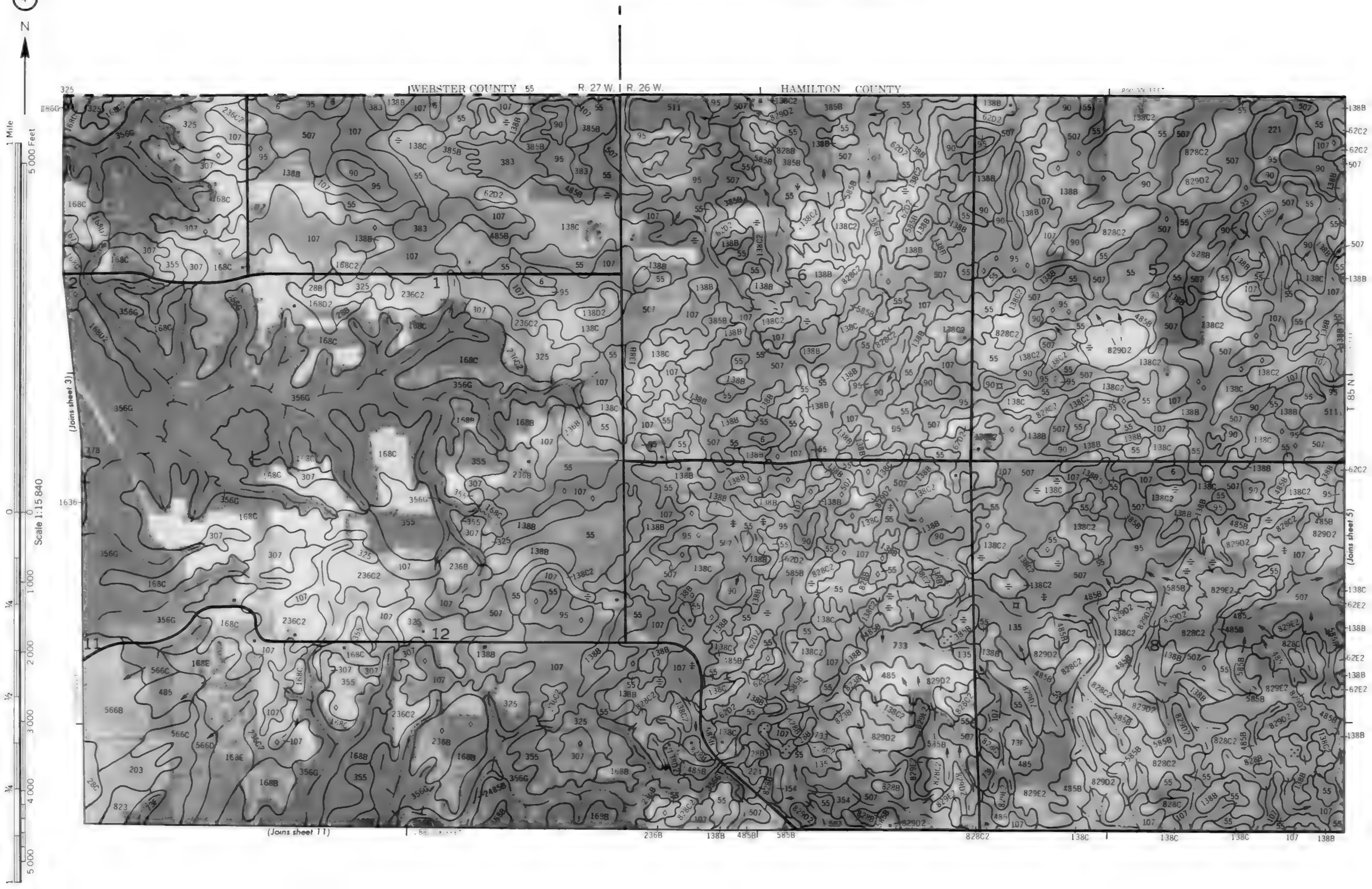
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Calcareous spot
- Better drained soil spot
- Sewage lagoon — S.L.

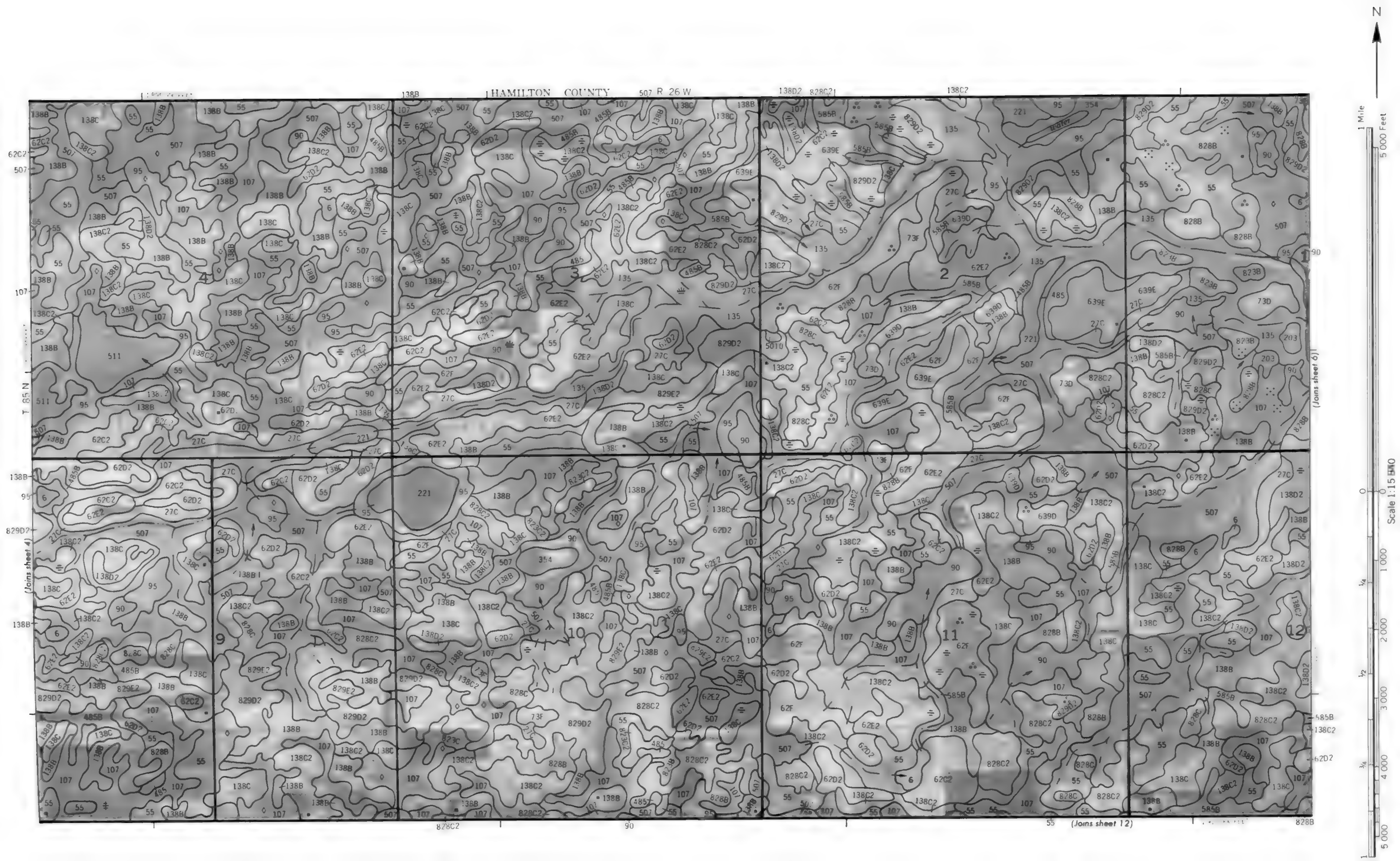

N
WEBSTER COUNTY
R. 28 W.
GREENE COUNTY
T. 85 N.
CHICAGO AND NORTH WESTERN
Beaver Creek
(Joins sheet 2)
(Joins sheet 8)
1 Mile
5 000 Feet
Scale 1:15 840


N
WEBSTER COUNTY
R 28 W | R 27 W
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 9)
T. 85 N.
Scale 1:15 840
1 Mile
5 000 Feet
Drainage Ditch 107
Drainage Ditch 107


3
N
WEBSTER COUNTY
R 27 W
T 85 N
DES MOINES RIVER
DES MOINES RIVER
Bluff Creek
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 10)
255 000 FEET
1 875 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840

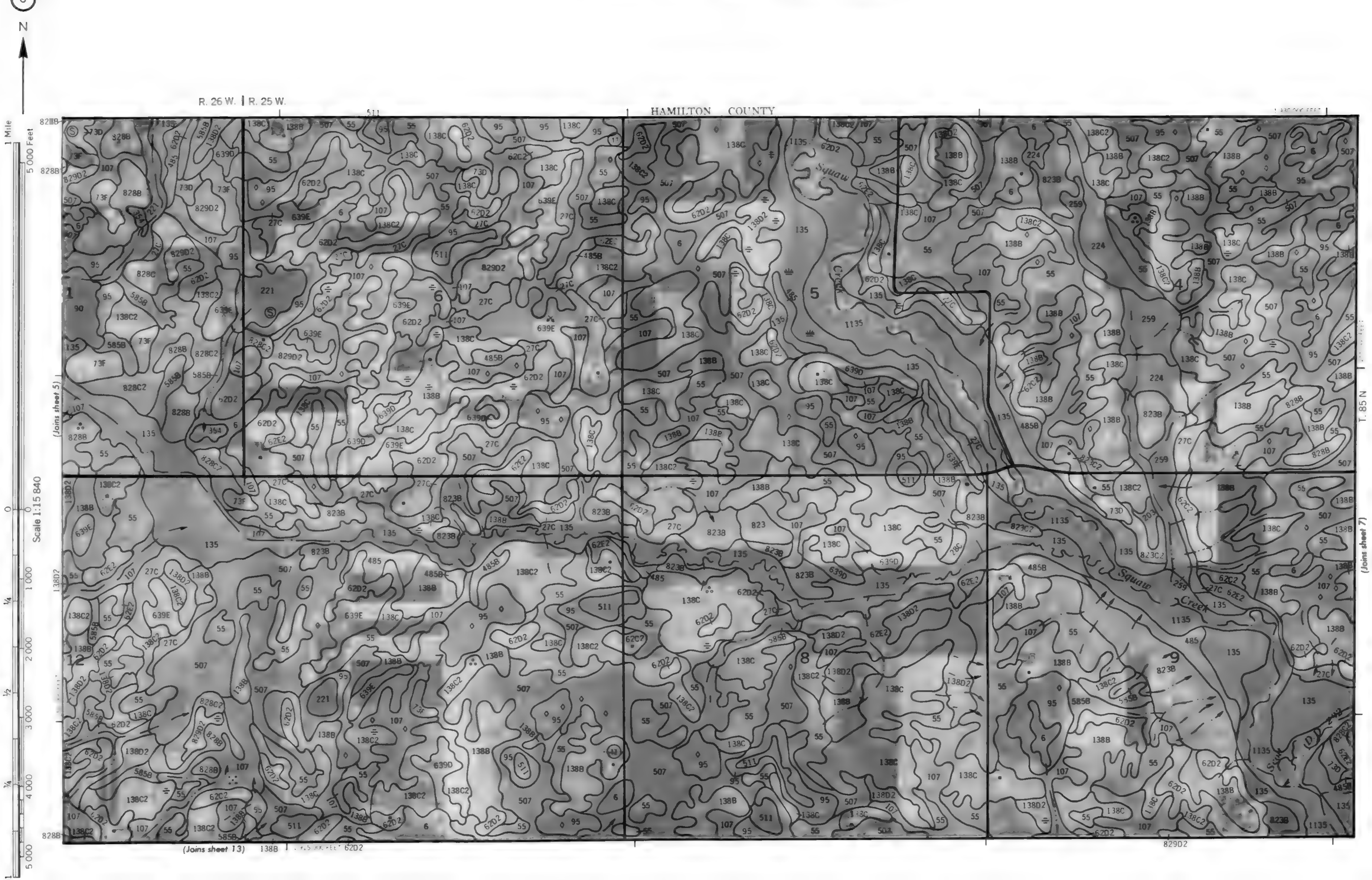
BOONE COUNTY, IOWA — SHEET NUMBER 4

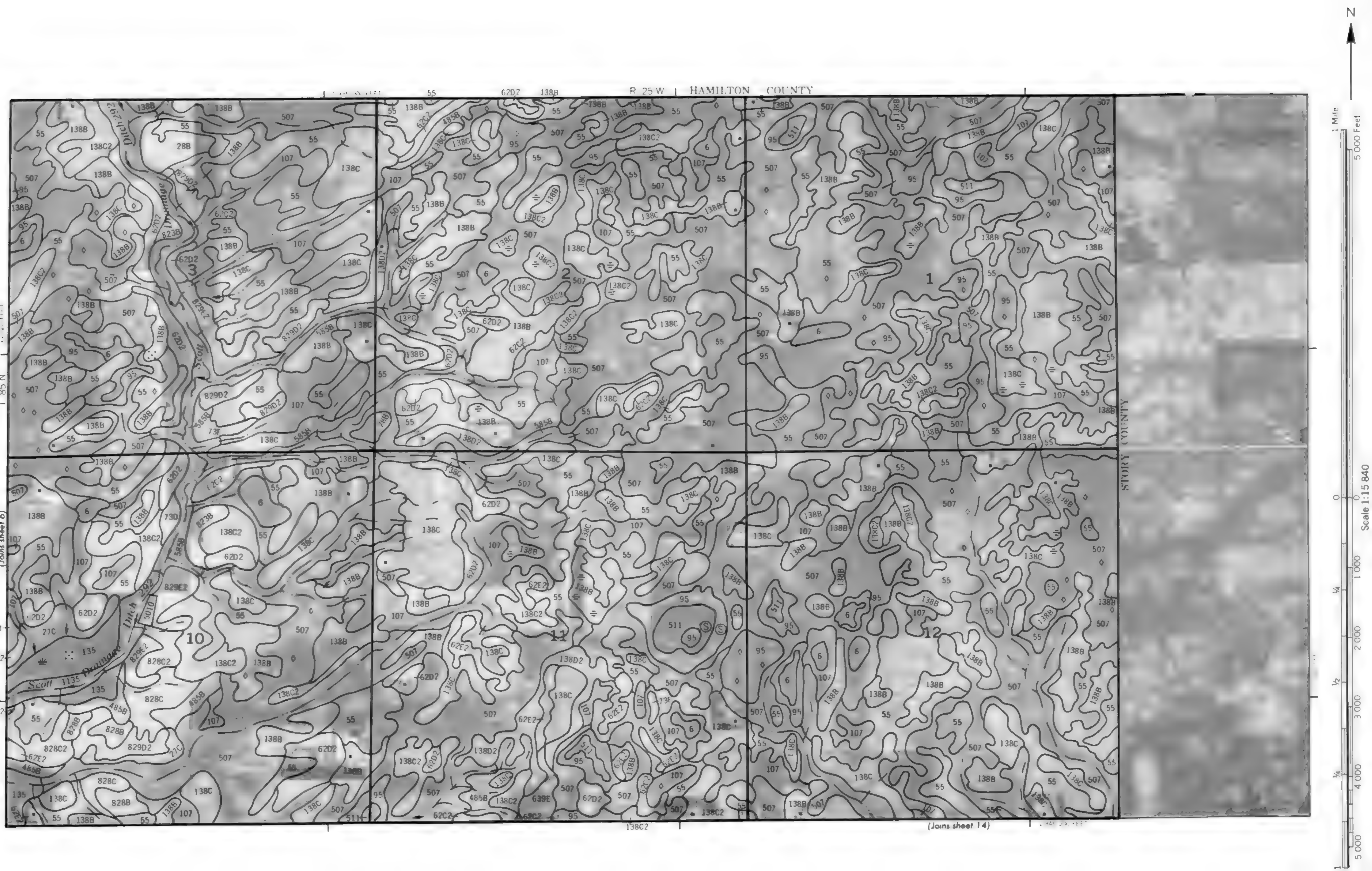


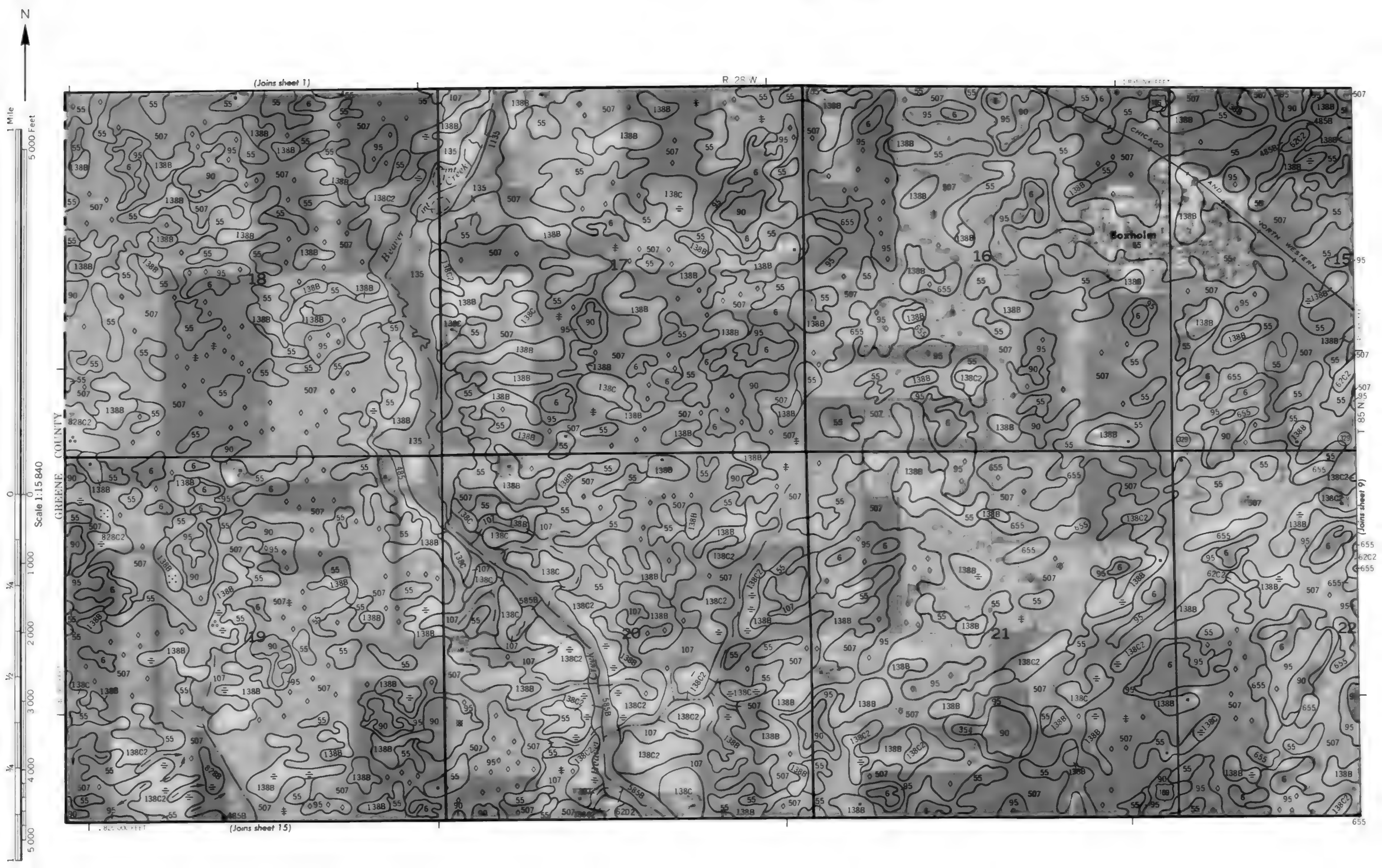


N
HAMILTON COUNTY
R. 26 W
T. 85 N
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 12)
1 Mile
5 000 Feet
Scale 1:15 840

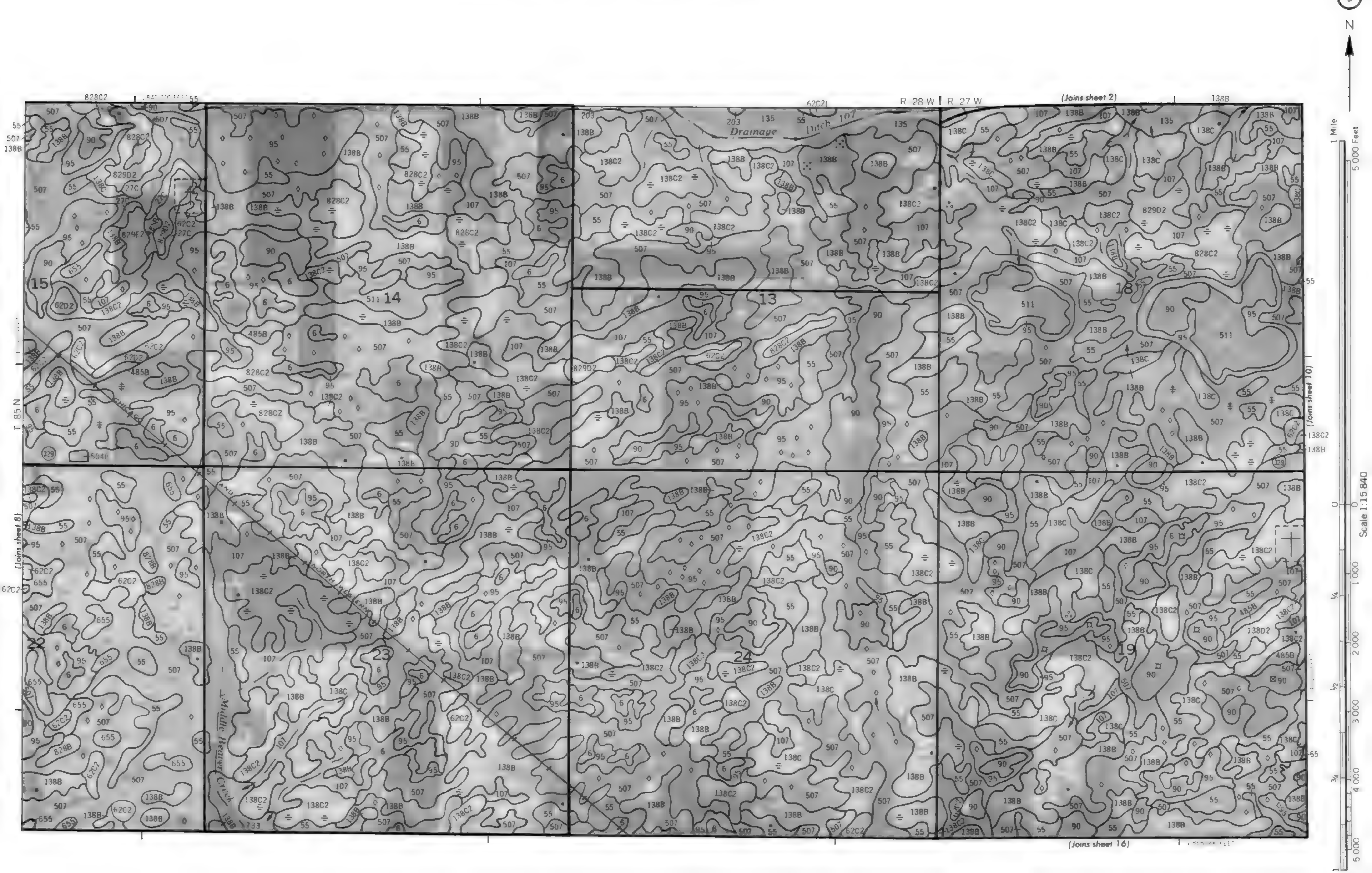
BOONE COUNTY, IOWA — SHEET NUMBER 6

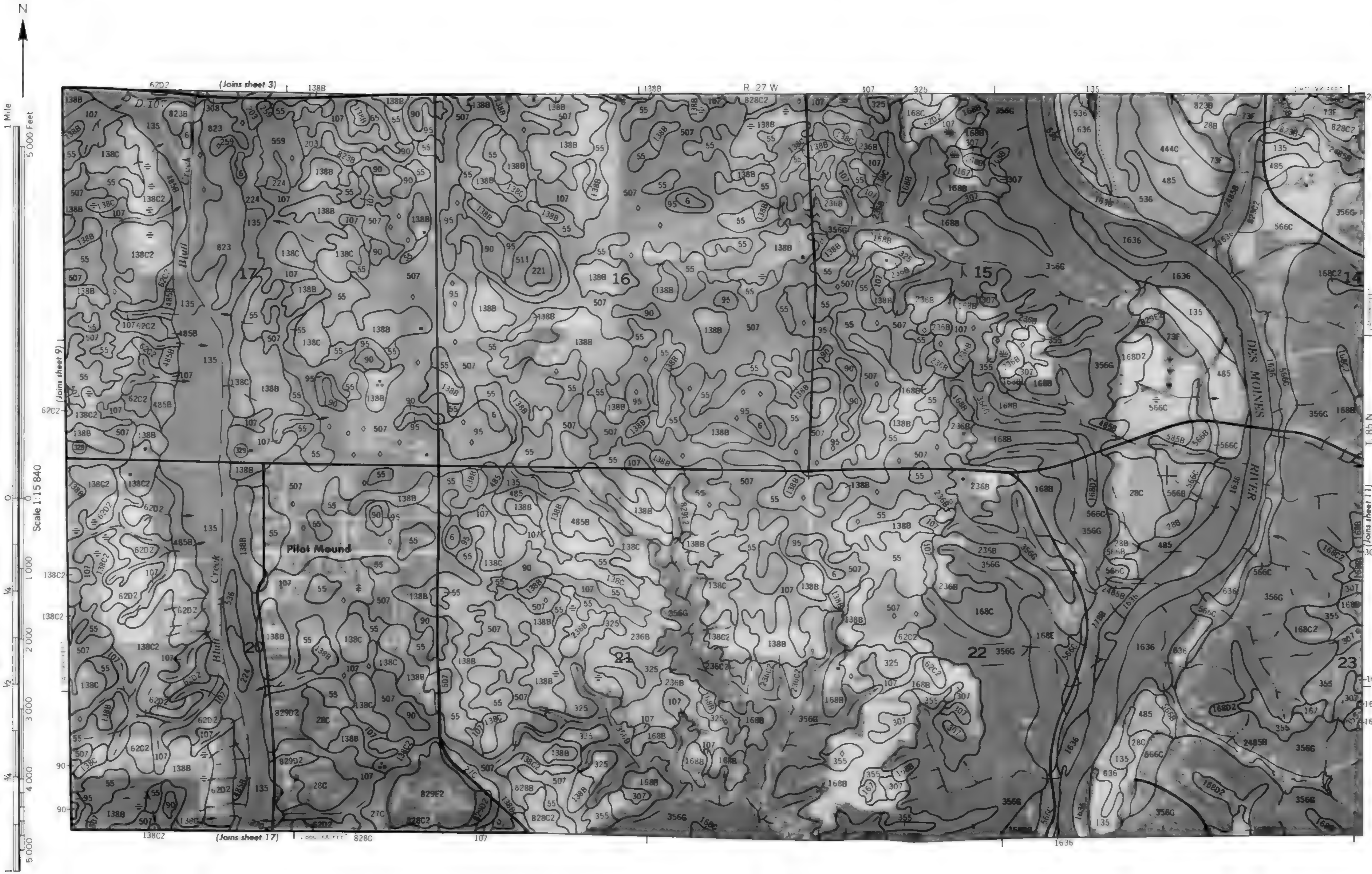


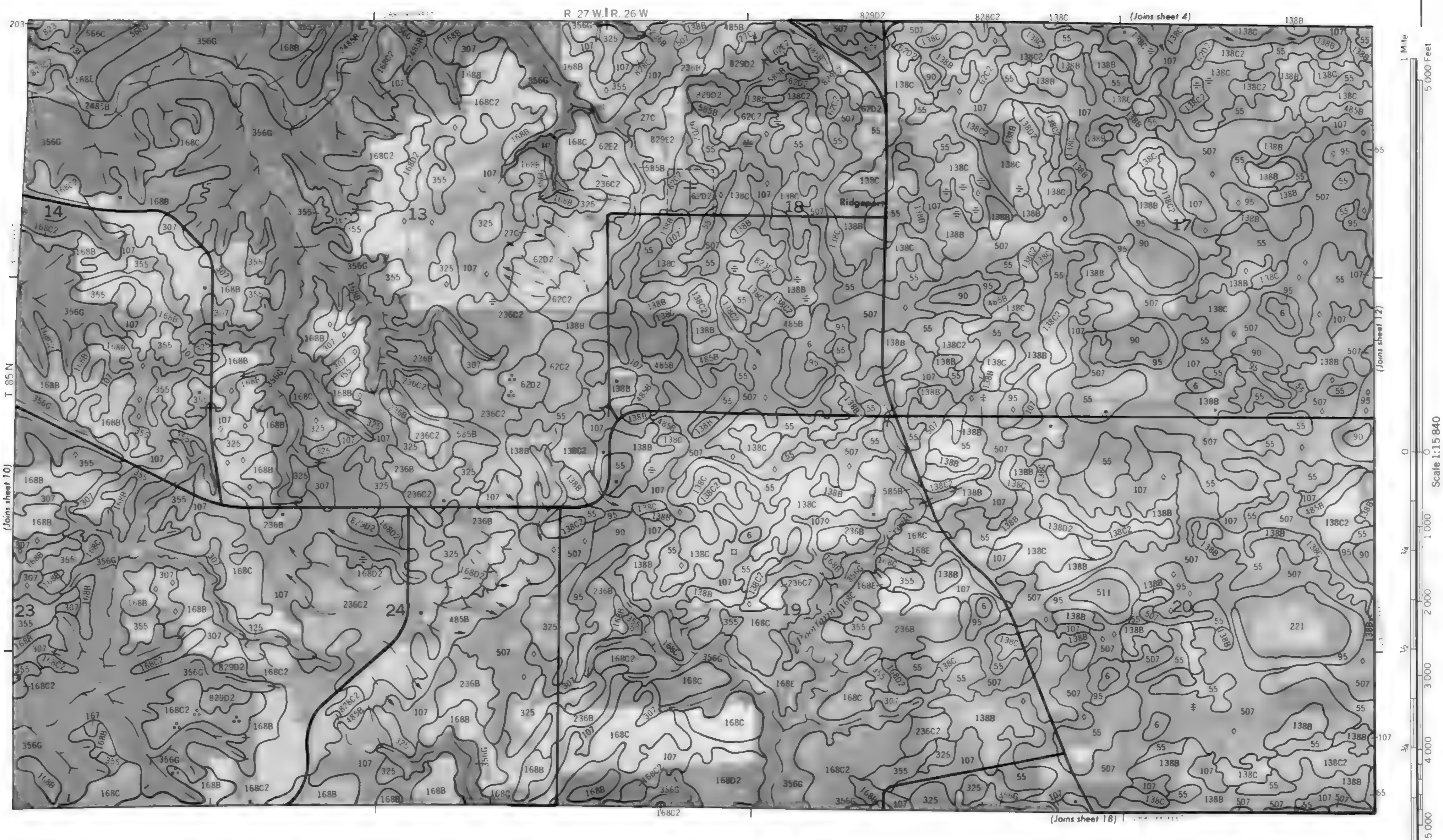

N
R 25 W
HAMILTON COUNTY
STORY COUNTY
T 85 N
(Joins sheet 6)
(Joins sheet 14)
Scott Drainage Ditch
1
2
3
10
11
12
1 Mile
5 000 Feet
Scale 1:15 840

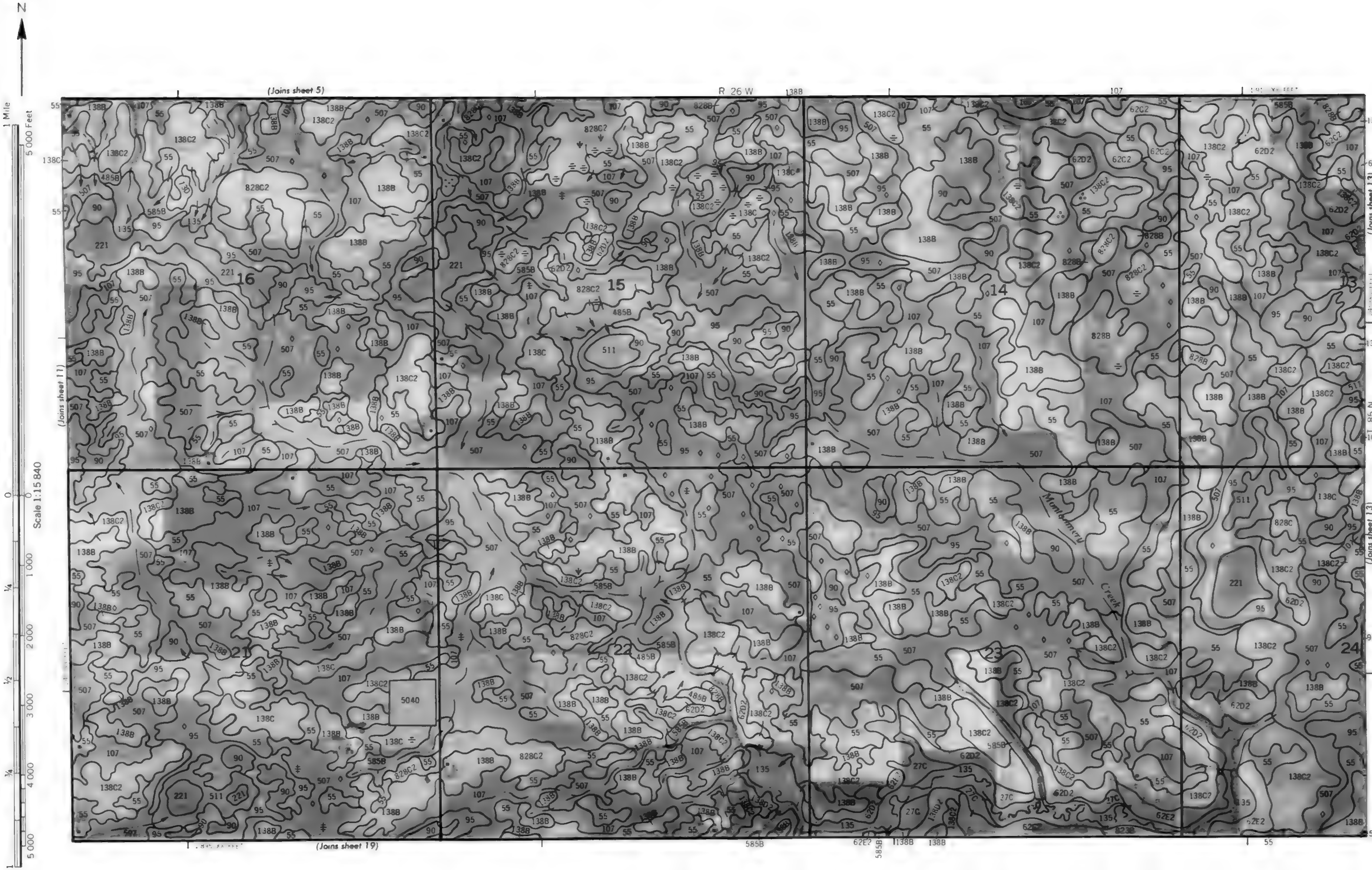

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 1)
(Joins sheet 15)
(Joins sheet 9)
R. 28 W.
T. 85 N.
GREENE COUNTY
Boxholm
CHICAGO AND NORTH WESTERN
Beaver Creek
18
17
16
15
19
20
21
22

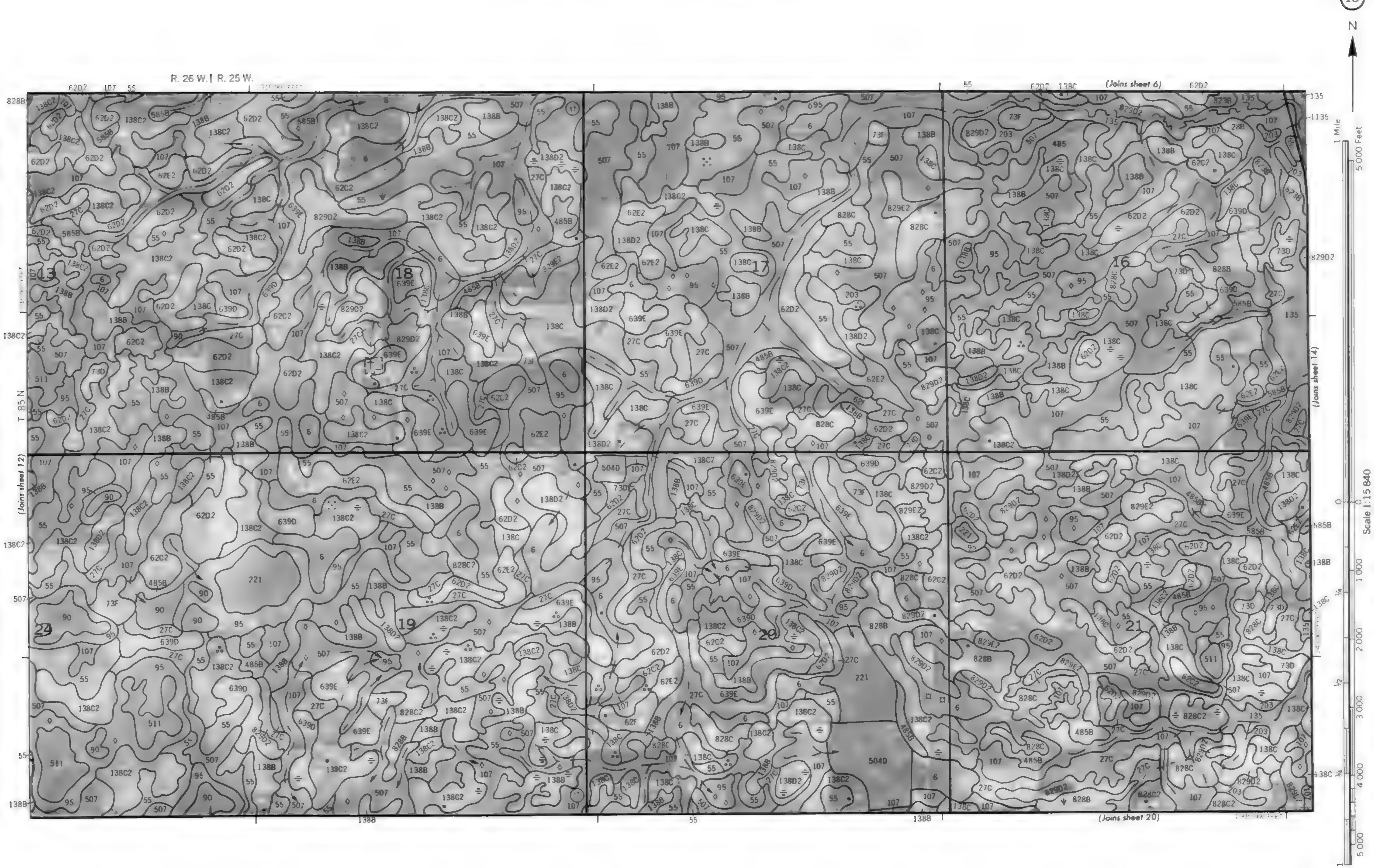
BOONE COUNTY, IOWA — SHEET NUMBER 9

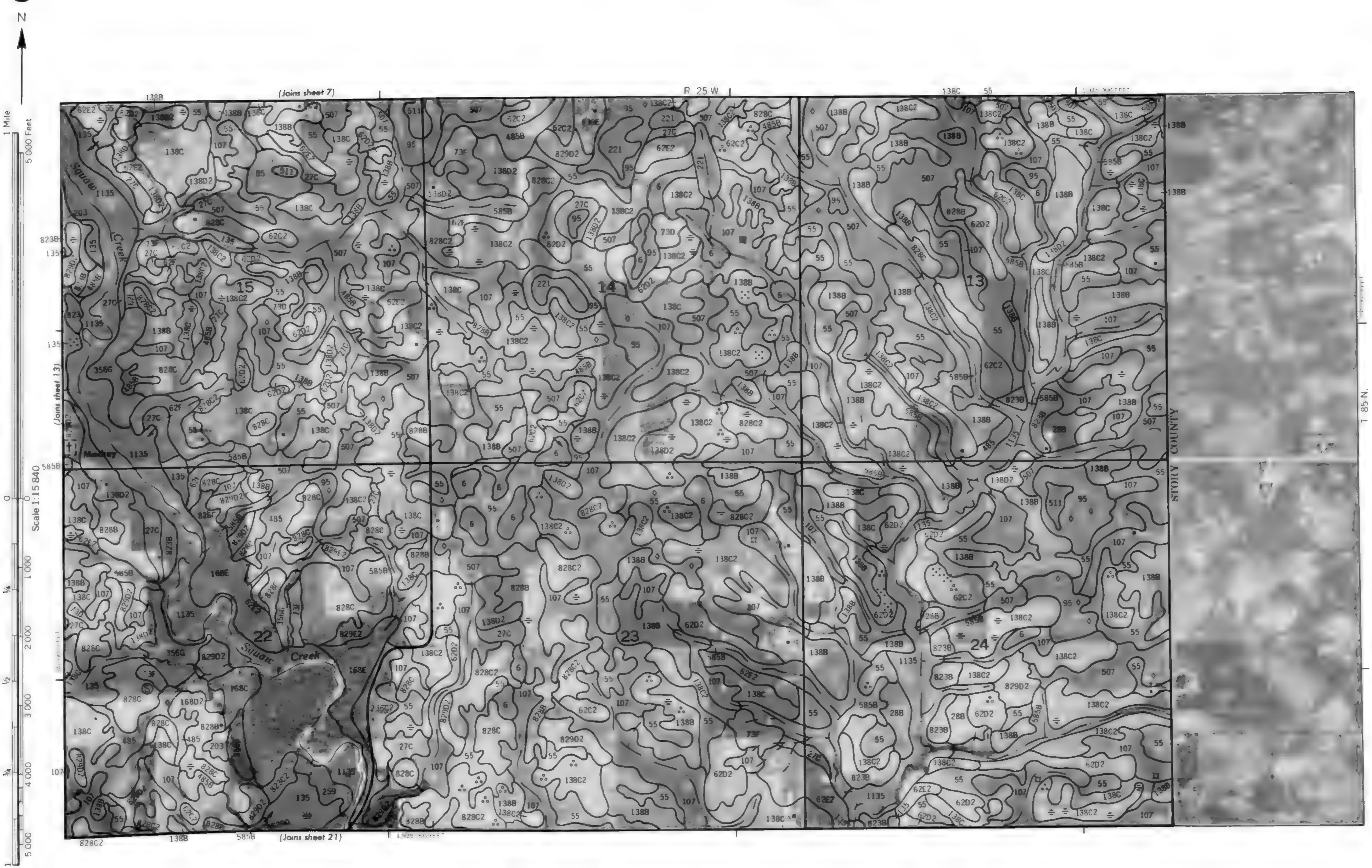



N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 3)
R. 27 W
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 17)
T. 85 N
Bluff Creek
Pilot Mound
DES MOINES RIVER
14
15
16
17
20
21
22
23

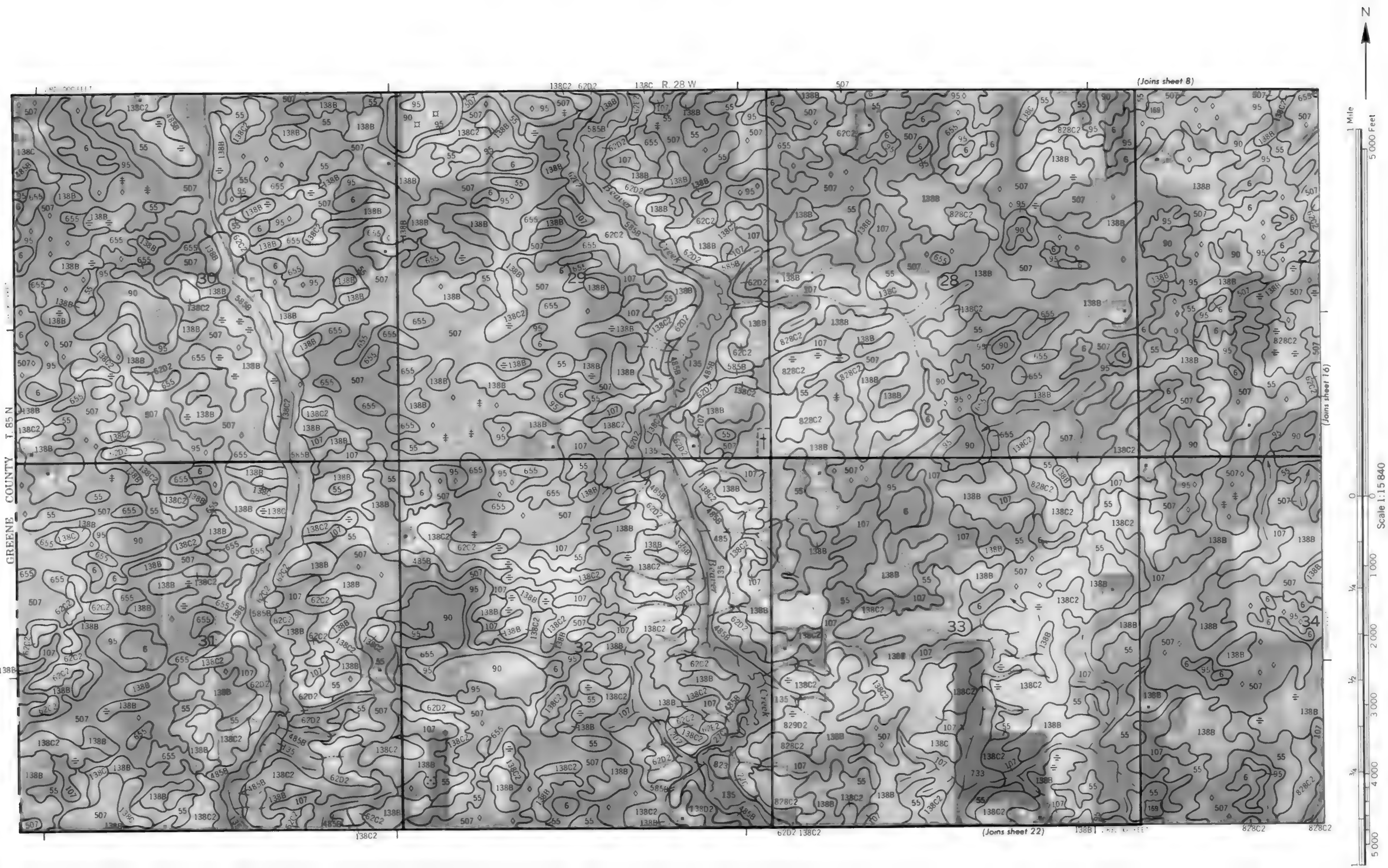

N
R. 27 W. | R. 26 W.
(Joins sheet 4)
(Joins sheet 12)
(Joins sheet 18)
(Joins sheet 10)
T 85 N
Ridgeport
Pounfarm Creek
13
14
17
18
19
20
23
24
Scale 1:15 840
1 Mile
5 000 Feet
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾
1

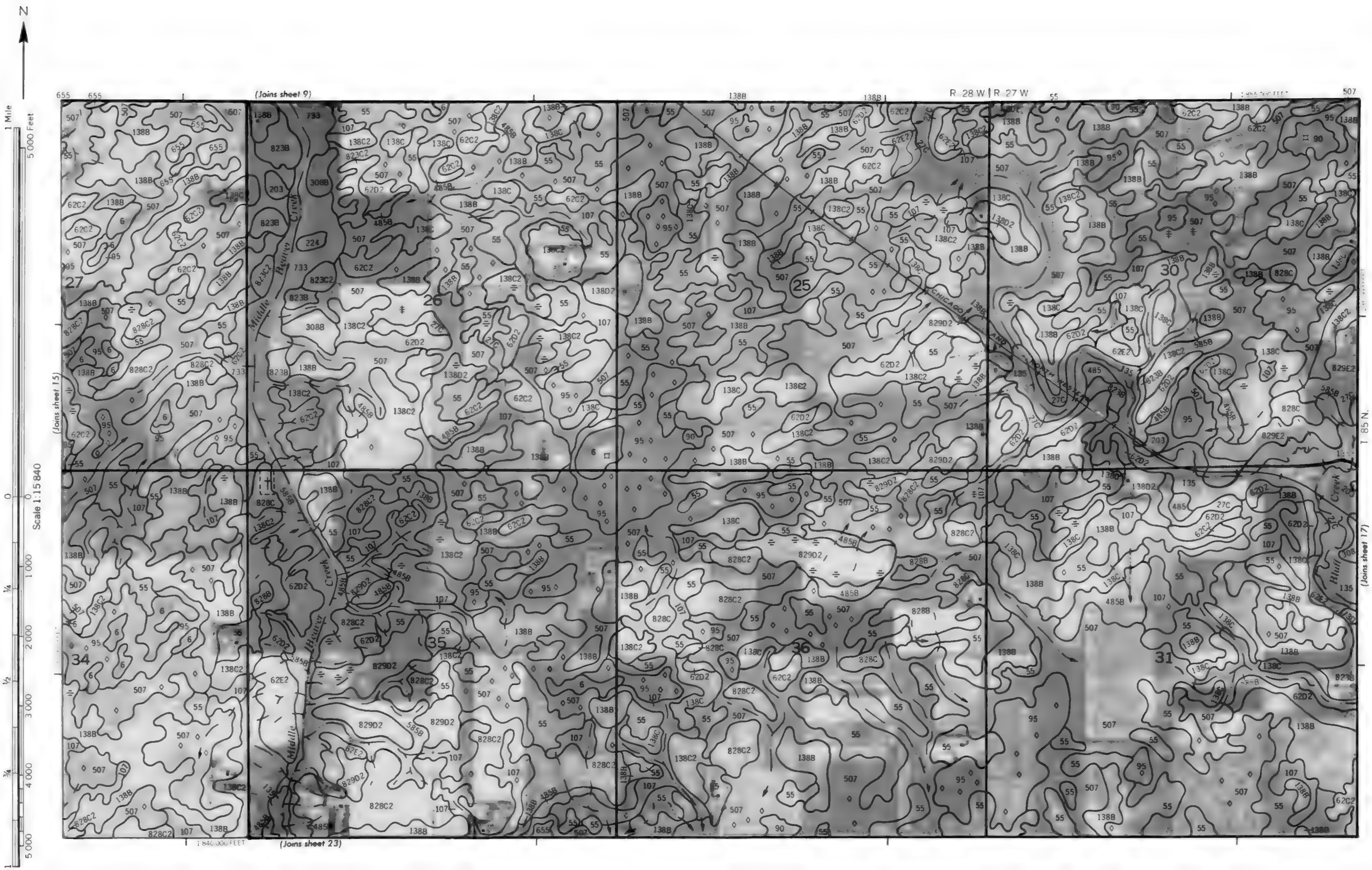

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 5)
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 19)
R 26 W
T 85 N
16
15
14
13
21
22
23
24
Montgomery Creek
5040

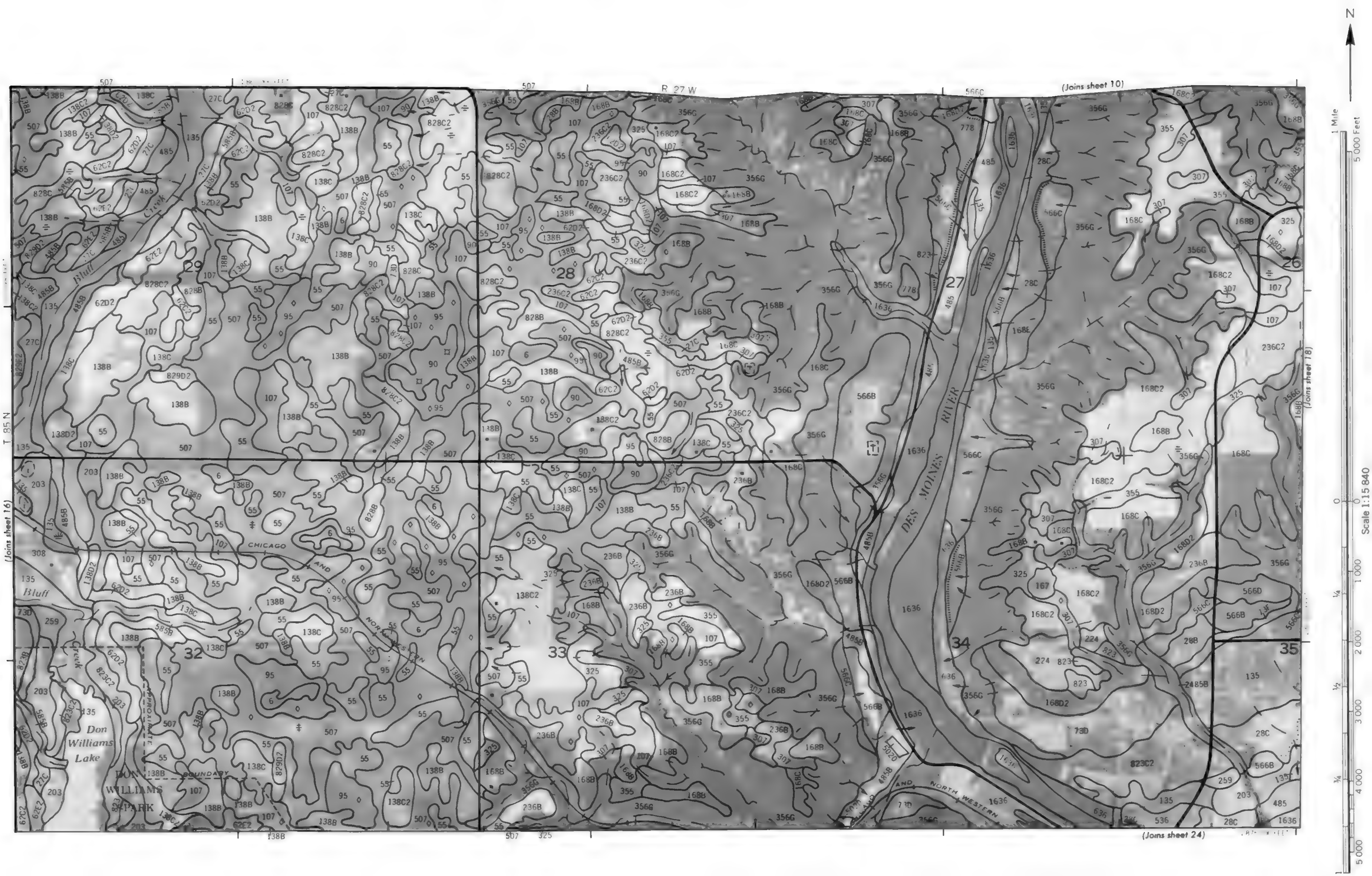

13
N
R. 26 W. | R. 25 W.
(Joins sheet 6)
(Joins sheet 14)
(Joins sheet 20)
(Joins sheet 12)
T. 85 N.
13
18
17
16
24
19
20
21
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
1/4
1/2
3/4

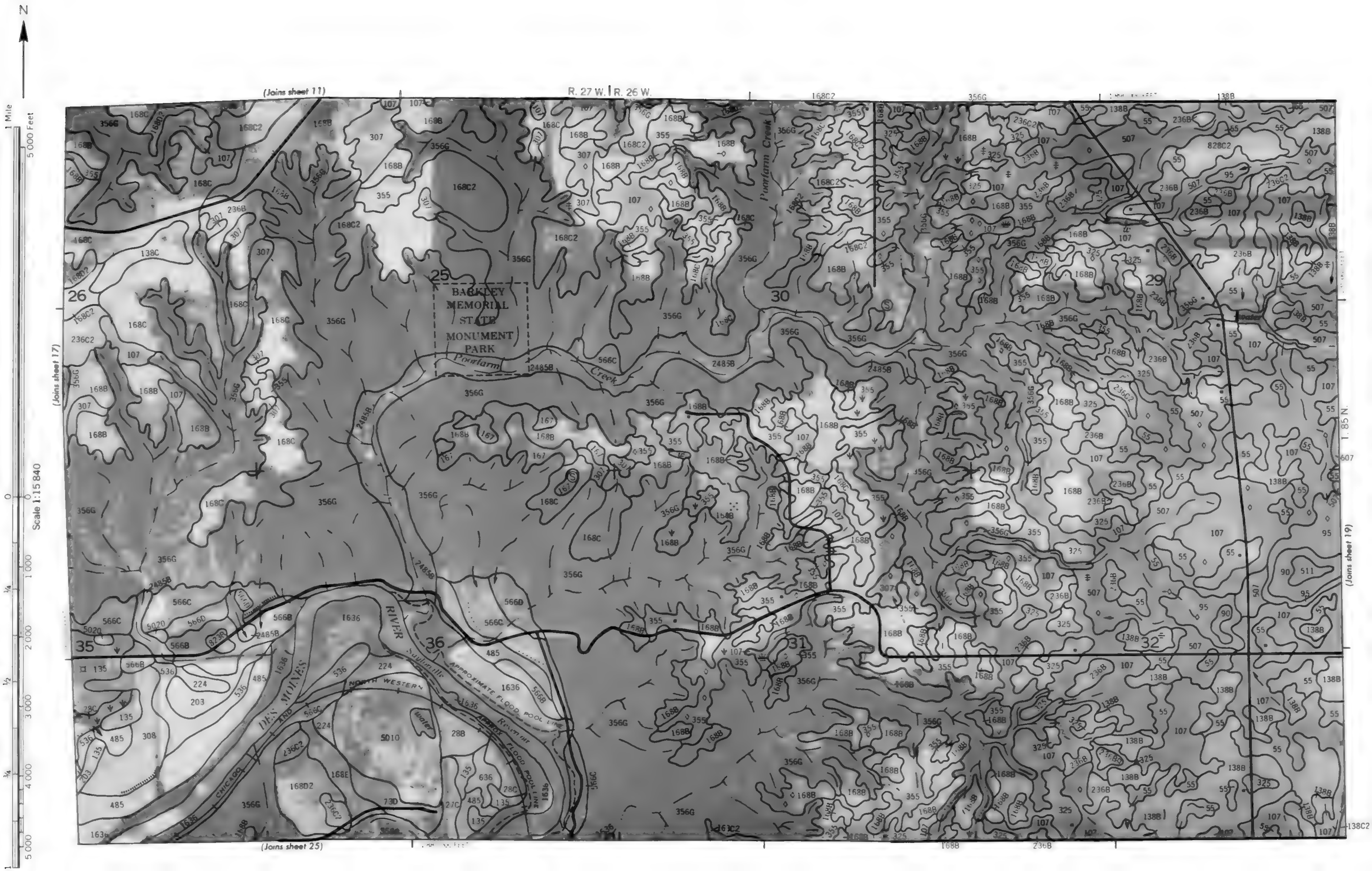

N
(Joins sheet 7)
R 25 W
(Joins sheet 13)
(Joins sheet 21)
STORY COUNTY
T 85 N
Squaw Creek
Squaw Creek
15
14
13
22
23
24
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾

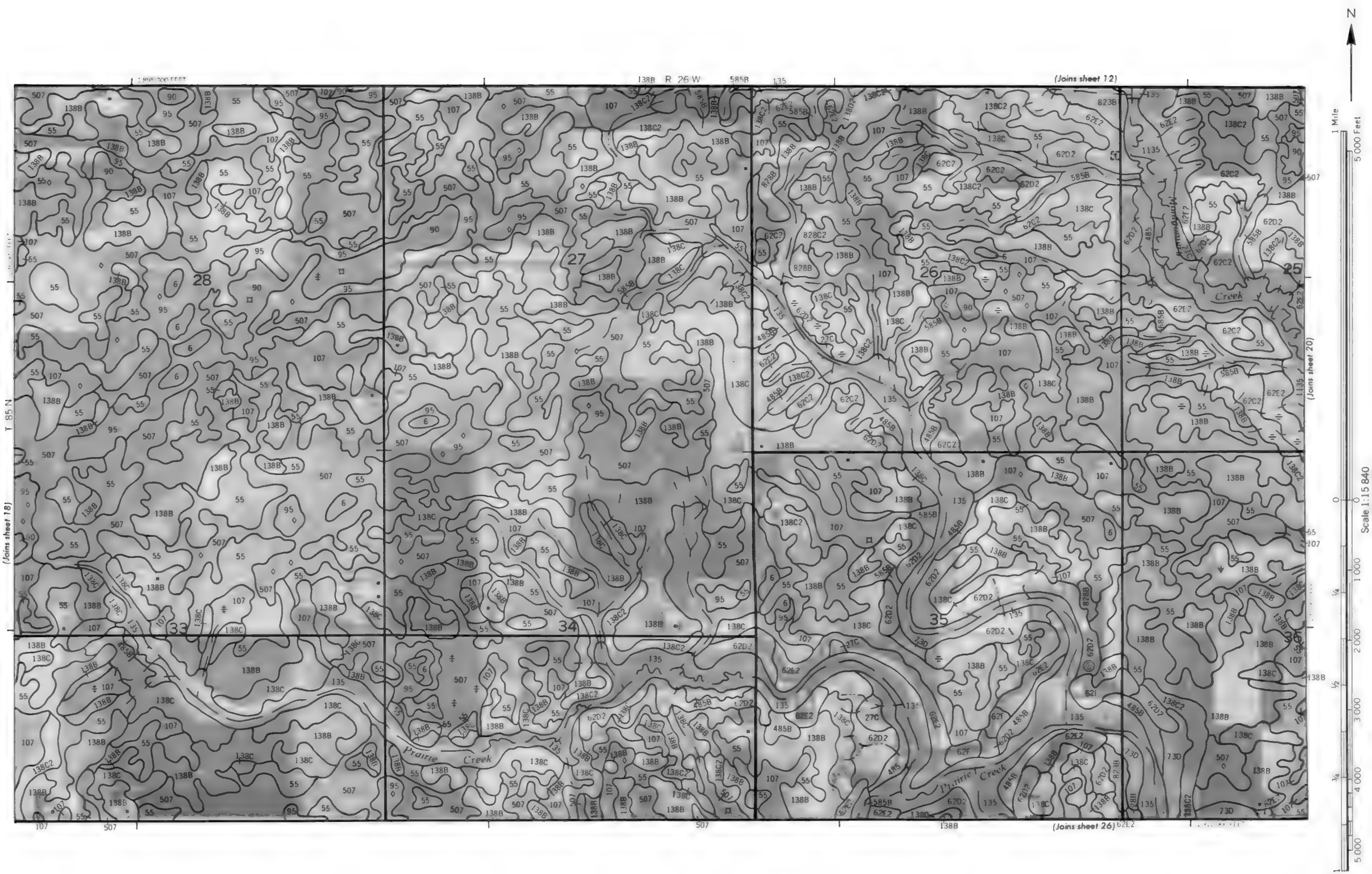
15

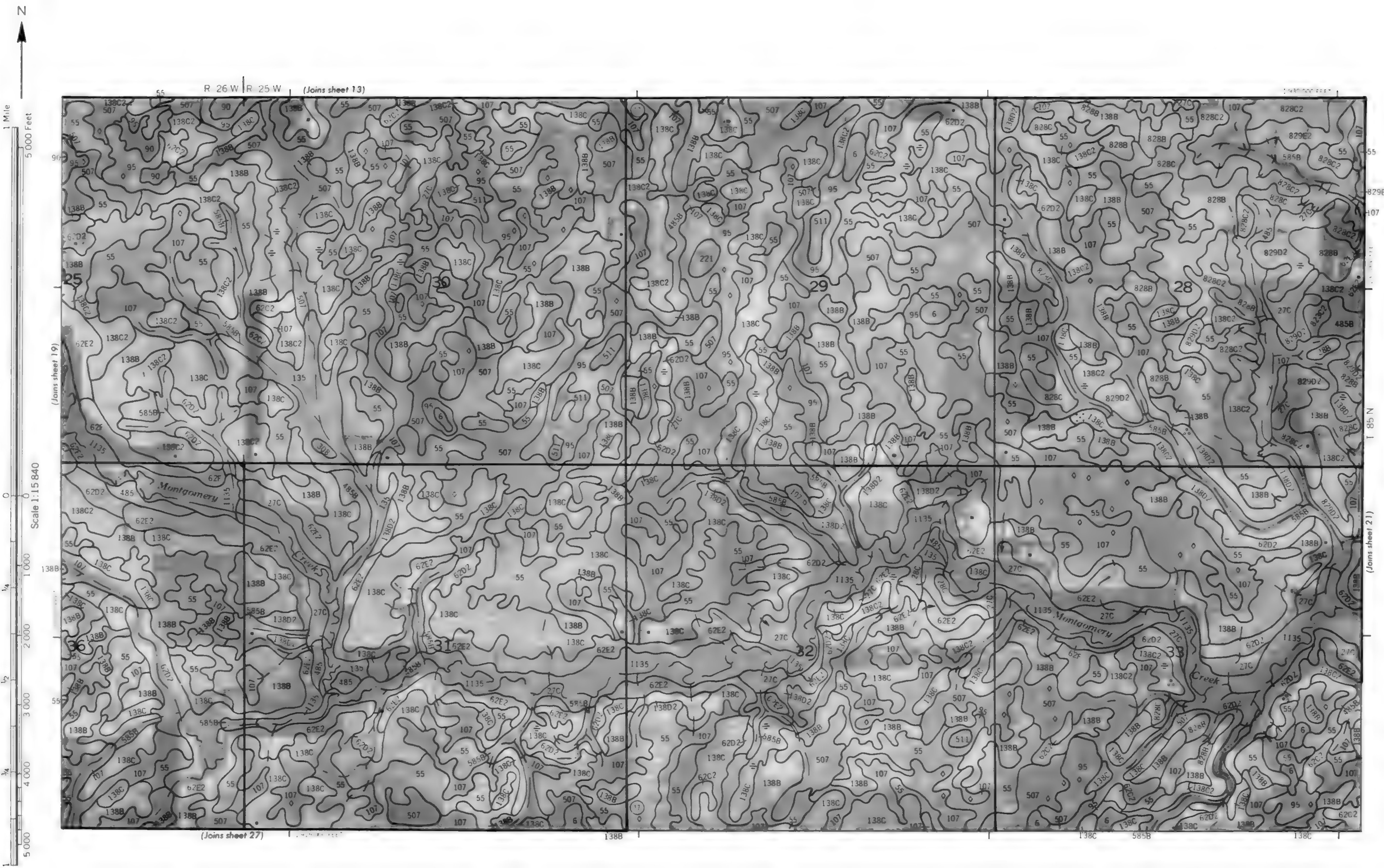

N
(Joins sheet 8)
R. 28 W
(Joins sheet 16)
(Joins sheet 22)
GREENE COUNTY
T. 85 N
Beaver Creek
30
29
28
27
31
32
33
34
1 Mile
5 000 Feet
Scale 1:15 840

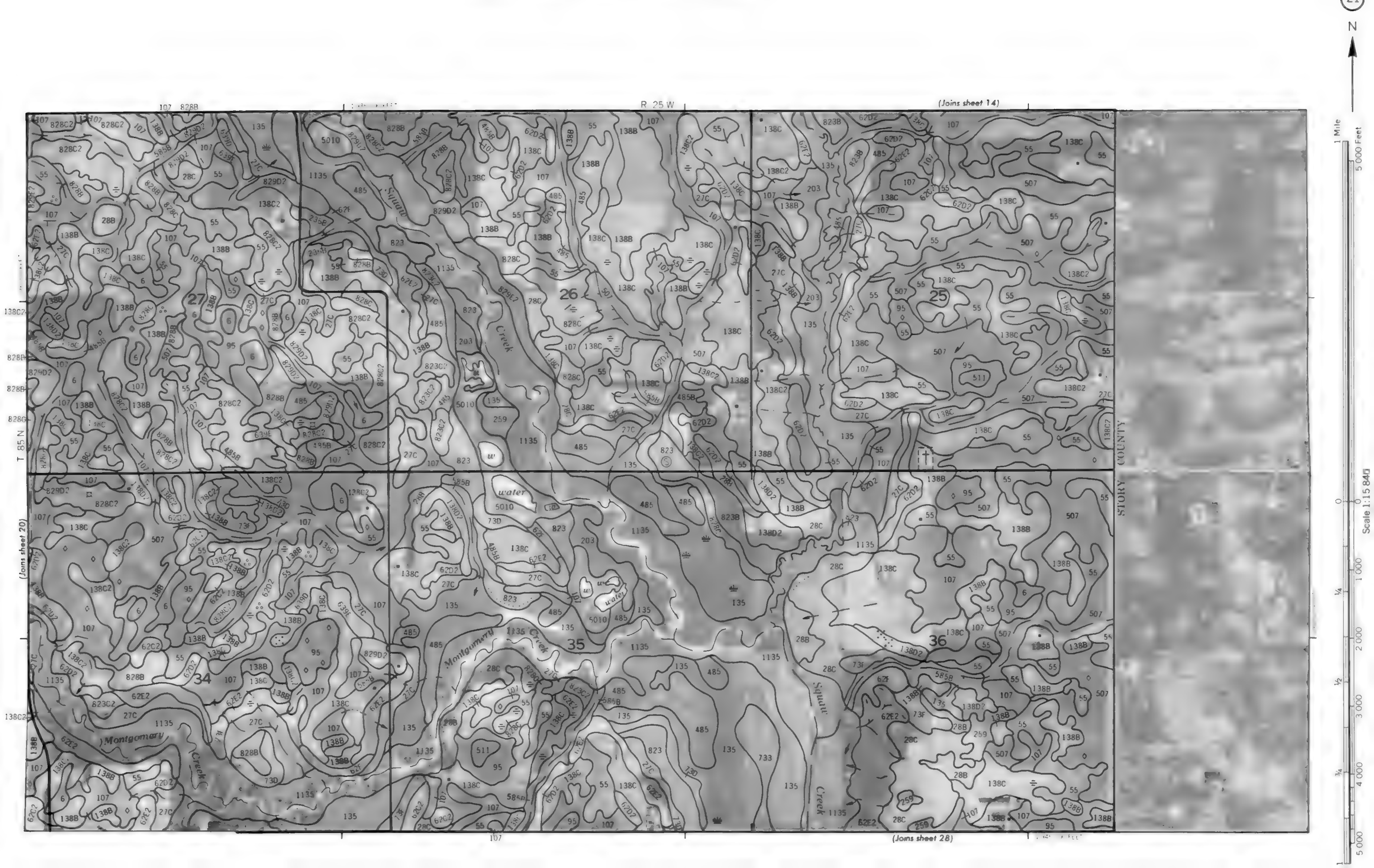

N
(Joins sheet 9)
(Joins sheet 15)
(Joins sheet 17)
(Joins sheet 23)
R 28 W
R 27 W
T 85 N.
Middle Beaver Creek
Bluff Creek
CHICAGO AND NORTH WESTERN
Scale 1:15 840
1 Mile
5 000 Feet

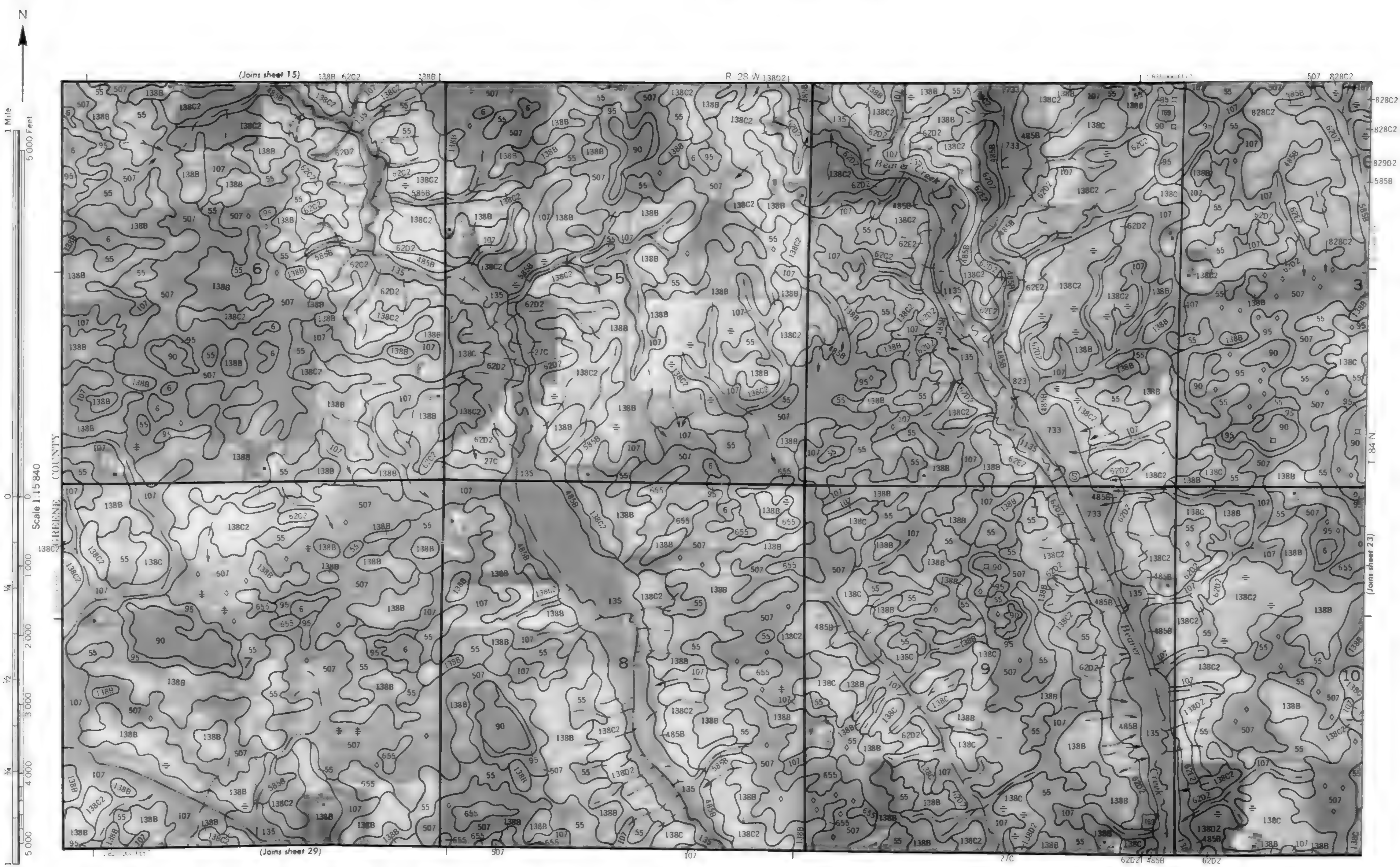

N
(Joins sheet 10)
(Joins sheet 16)
(Joins sheet 18)
(Joins sheet 24)
R. 27 W.
T. 85 N.
DES MOINES RIVER
CHICAGO AND NORTH WESTERN
Bluff Creek
Don Williams Lake
DON WILLIAMS PARK
APPROXIMATE BOUNDARY
29
28
27
26
32
33
34
35
1 Mile
5 000 Feet
Scale 1:15 840

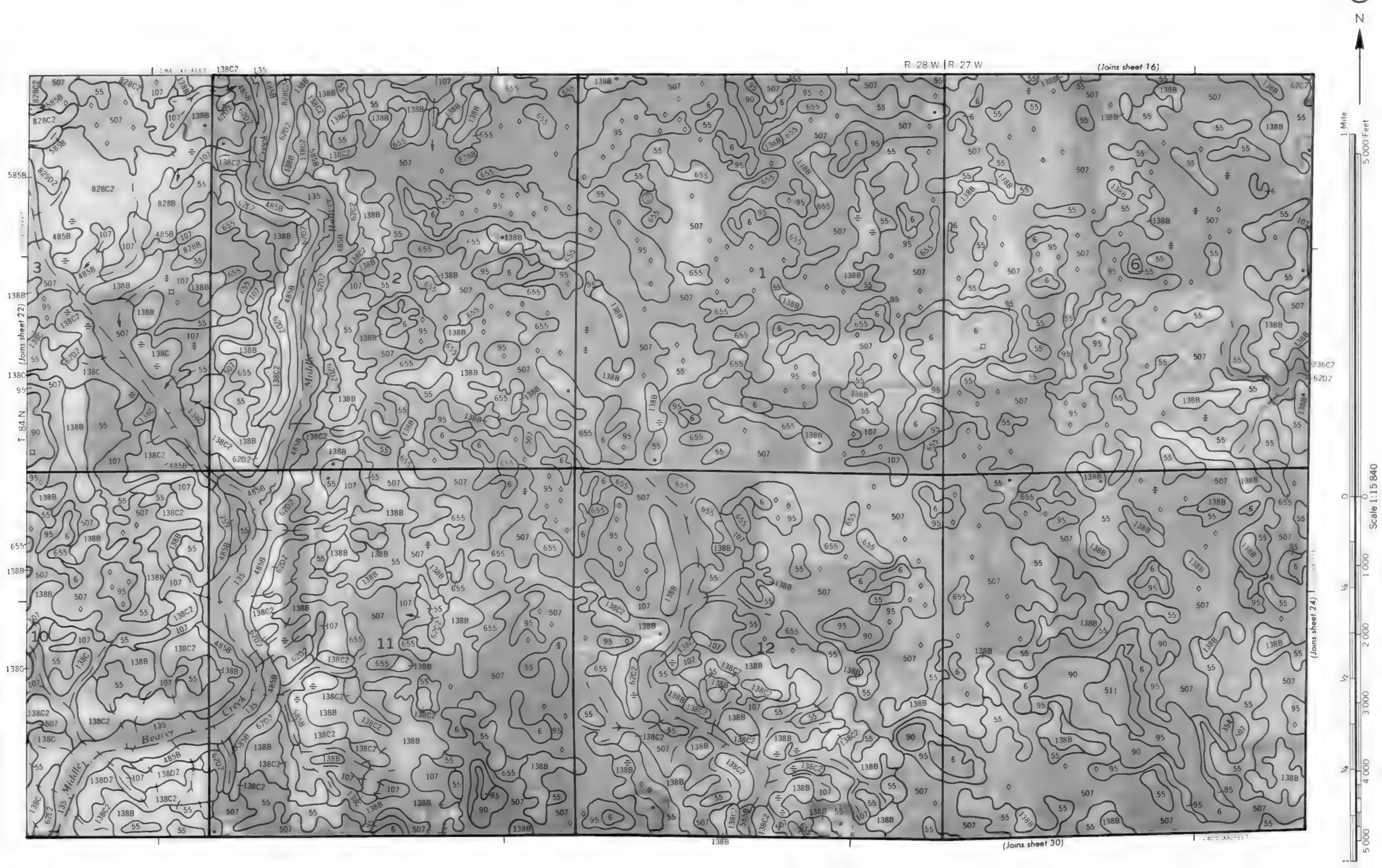

N
(Joins sheet 11)
R. 27 W. | R. 26 W.
(Joins sheet 17)
(Joins sheet 19)
(Joins sheet 25)
T. 85 N.
BARKLEY MEMORIAL STATE MONUMENT PARK
Poorfarm Creek
DES MOINES RIVER
CHICAGO AND NORTH WESTERN
APPROXIMATE FLOOD POOL LINE
Saylorville Reservoir
water
25
26
29
30
31
32
35
36
1 Mile
5 000 Feet
Scale 1:15 840

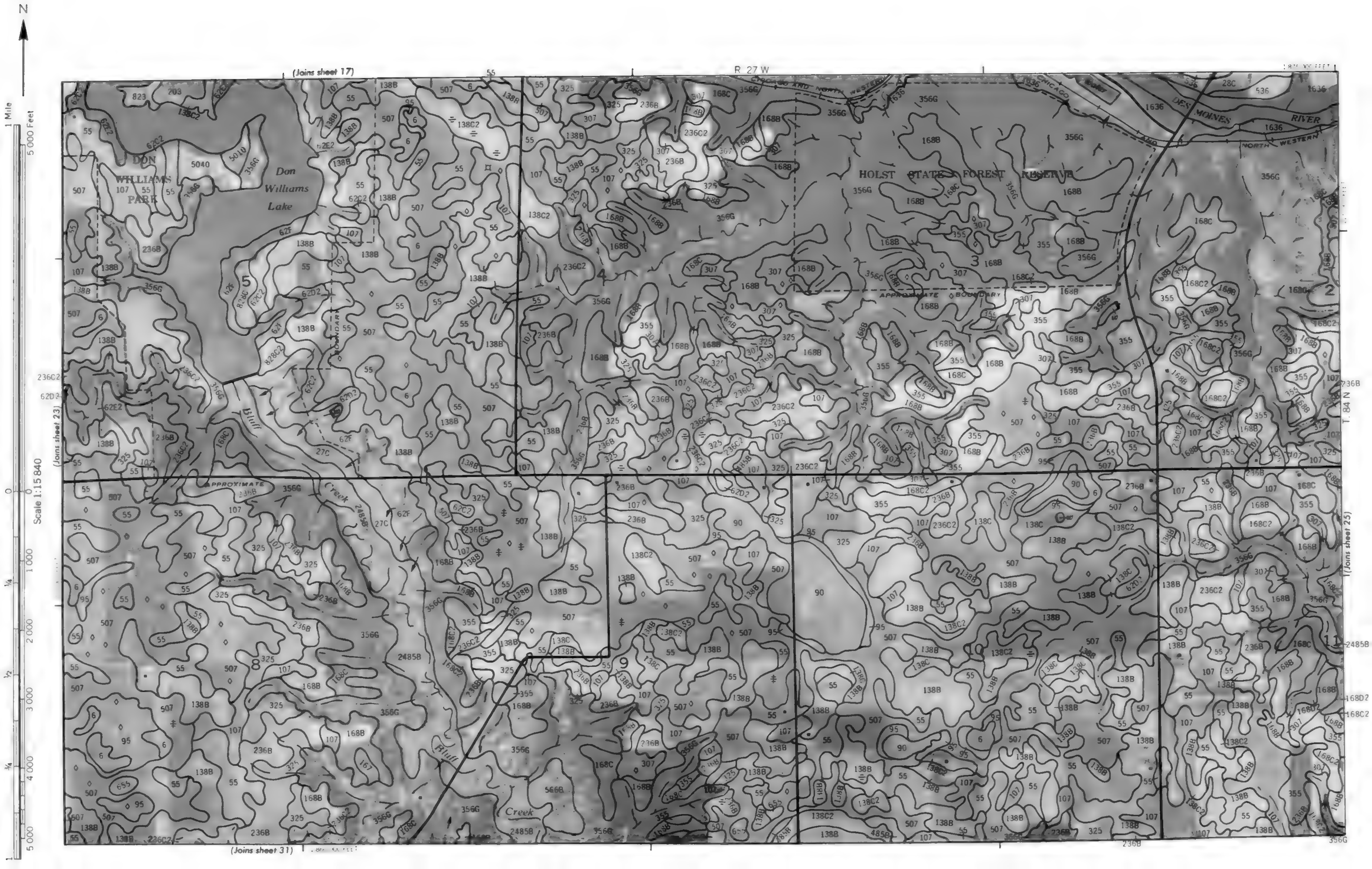

N
(Joins sheet 12)
R 26 W
T 85 N
(Joins sheet 18)
(Joins sheet 20)
(Joins sheet 26)
27
28
26
25
33
34
35
36
Prairie Creek
Prairie Creek
Creek
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000

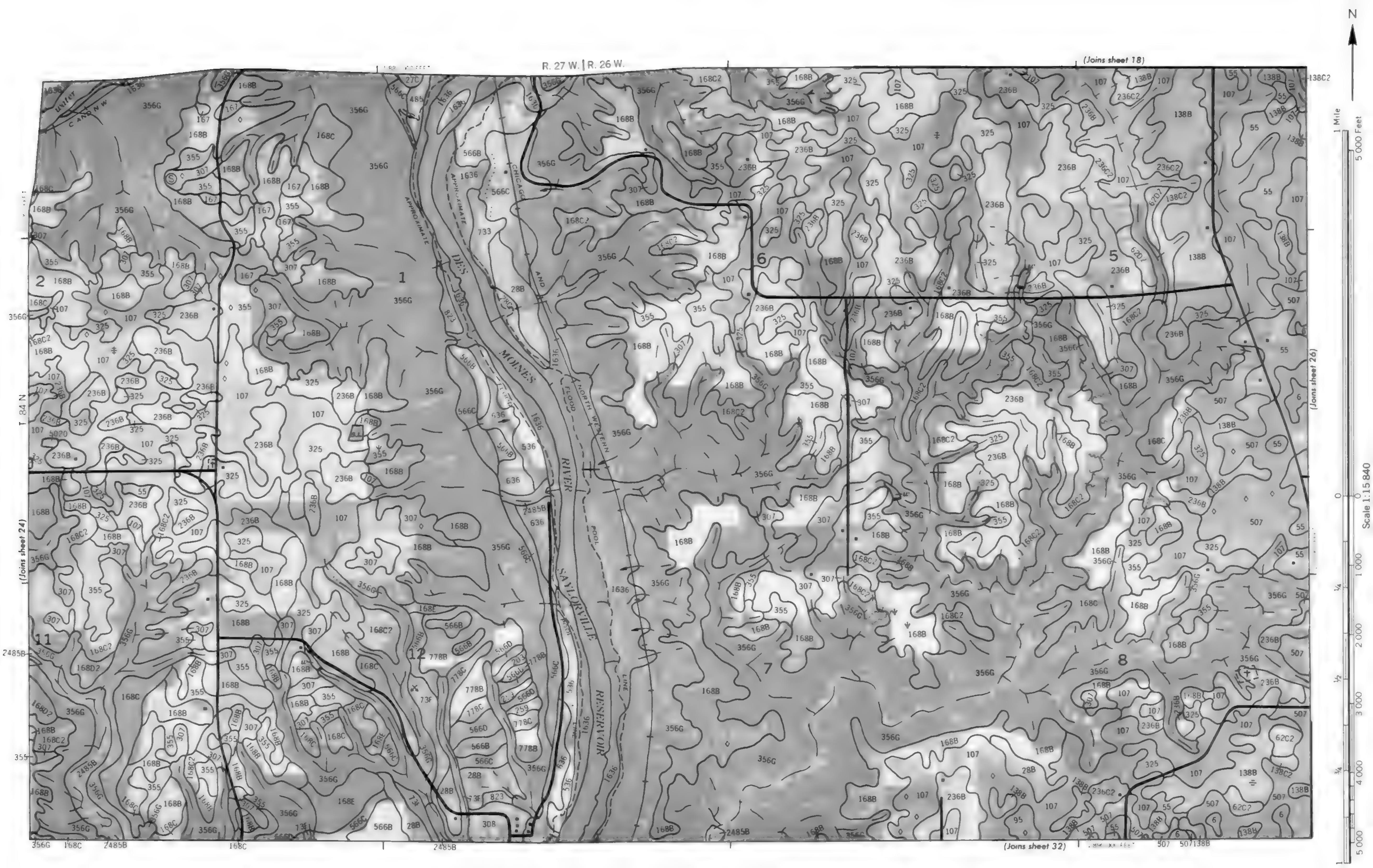

N
R 26 W
R 25 W
(Joins sheet 13)
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 27)
T 85 N
Montgomery Creek
Montgomery
Creek
25
30
29
28
36
31
32
33
1 Mile
5 000 Feet
Scale 1:15 840

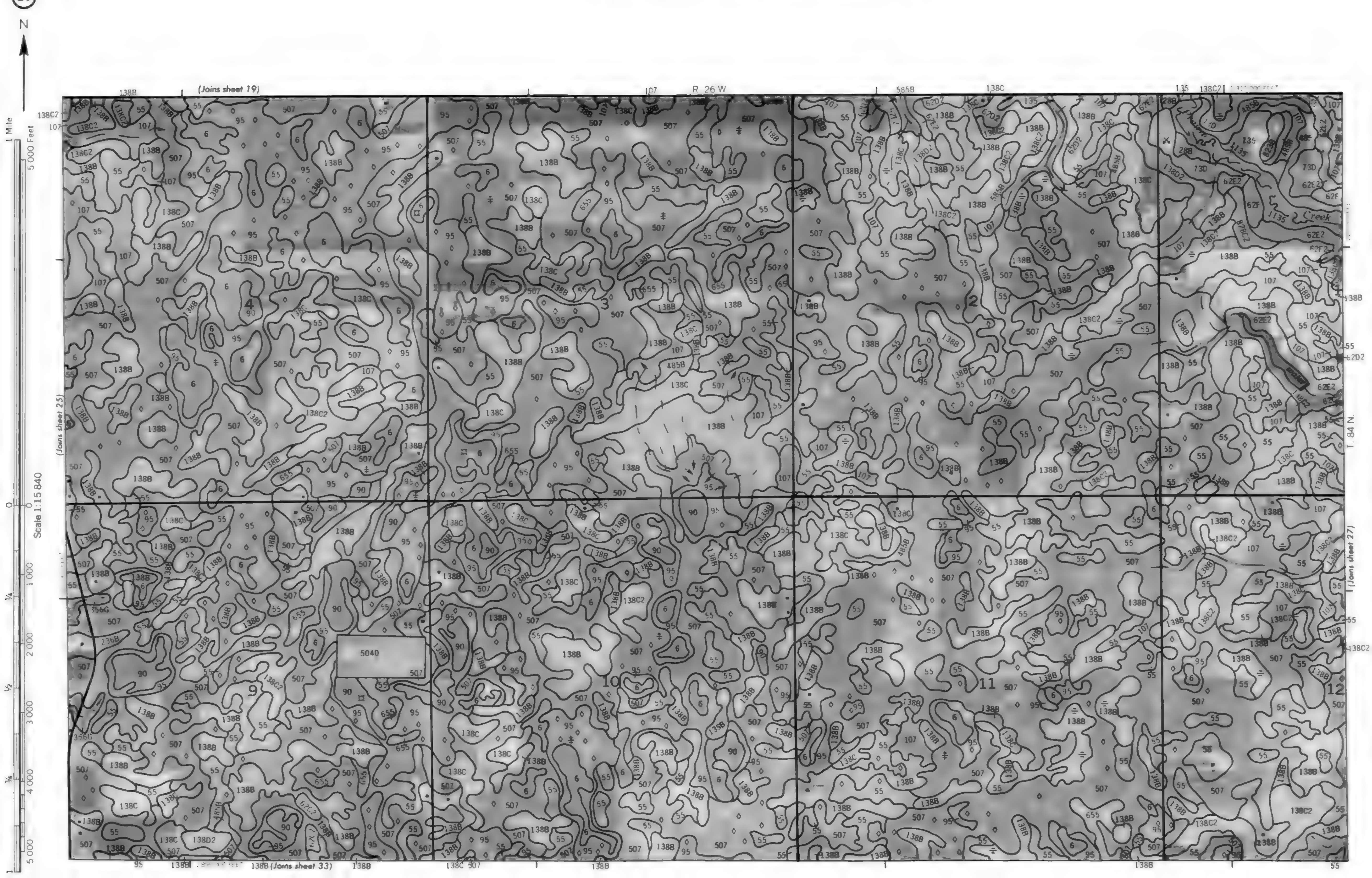

21
N
R 25 W
(Joins sheet 14)
(Joins sheet 20)
(Joins sheet 28)
T 85 N
STORY COUNTY
Squaw Creek
Montgomery Creek
26
25
27
34
35
36
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000

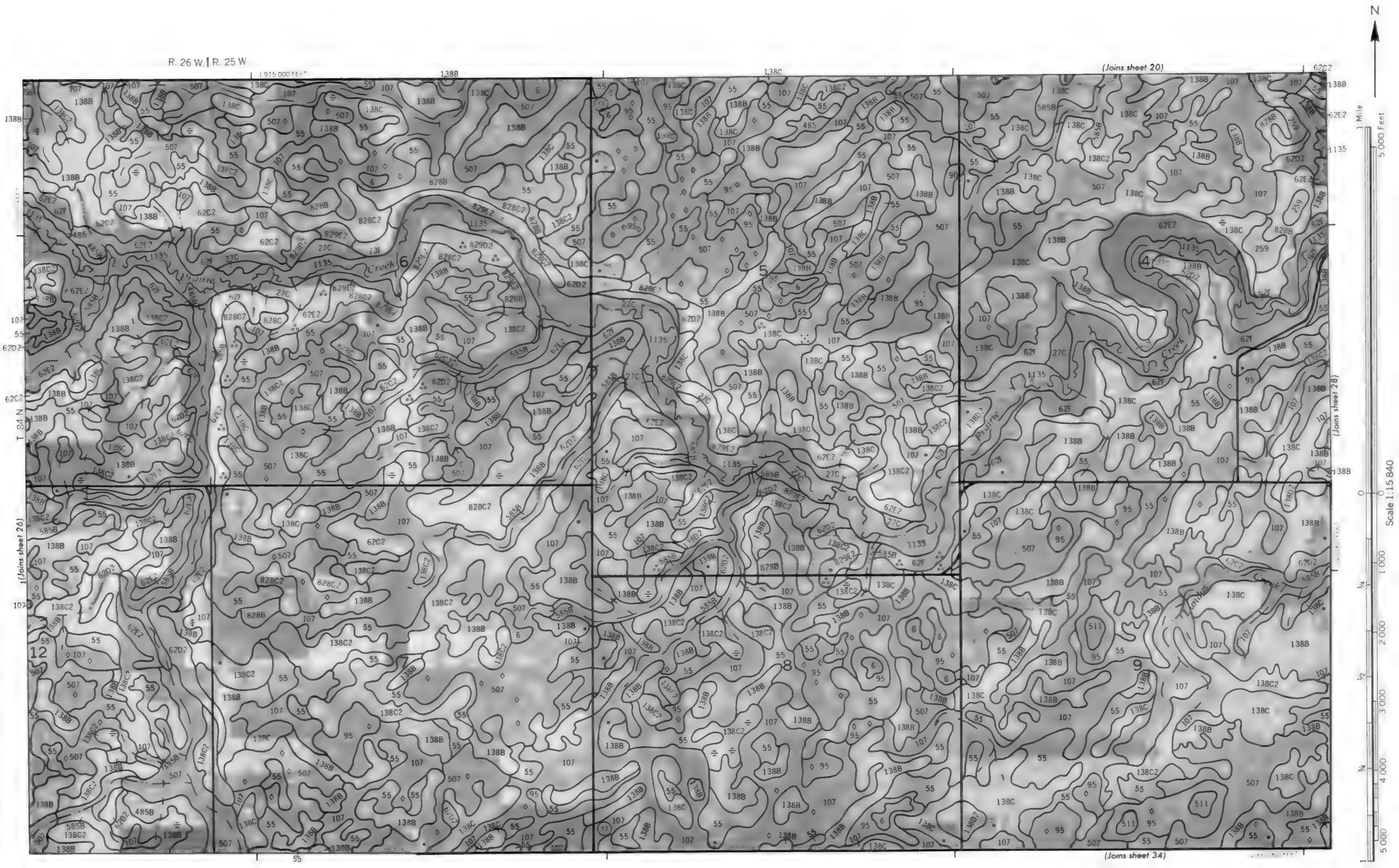

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 15)
R. 28 W.
(Joins sheet 23)
T. 84 N.
(Joins sheet 29)
GREENE COUNTY
Beaver Creek
Beaver Creek


23
N
R 28 W | R 27 W
(Joins sheet 16)
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 30)
T 84 N
Middle
Creek
Beaver
Scale 1:15 840
1 Mile
5 000 Feet

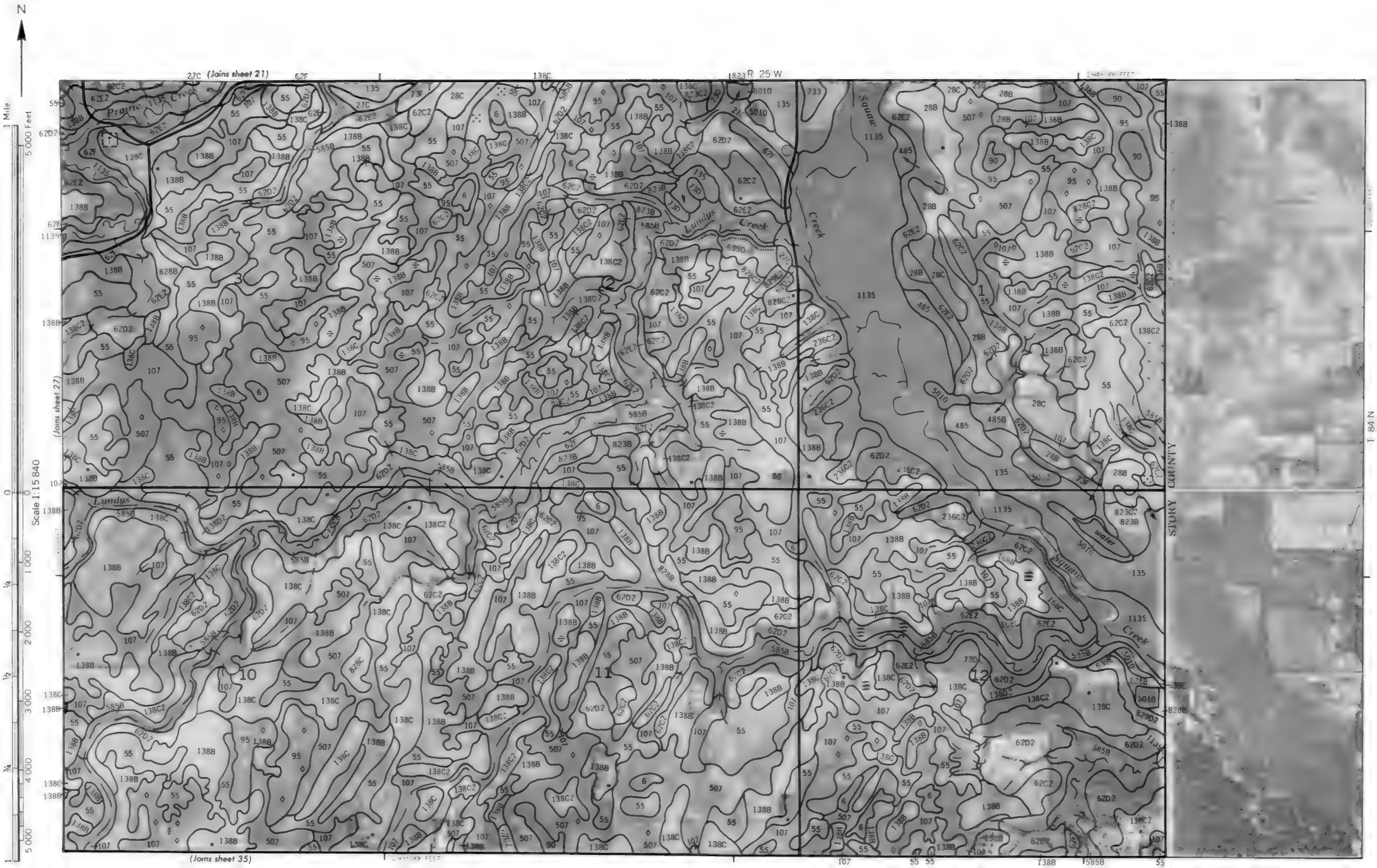

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 17)
(Joins sheet 23)
(Joins sheet 25)
(Joins sheet 31)
R 27 W
T. 84 N
DON WILLIAMS PARK
Don Williams Lake
HOLST STATE FOREST RESERVE
DES MOINES RIVER
CHICAGO AND NORTH WESTERN
APPROXIMATE BOUNDARY
Bluff Creek

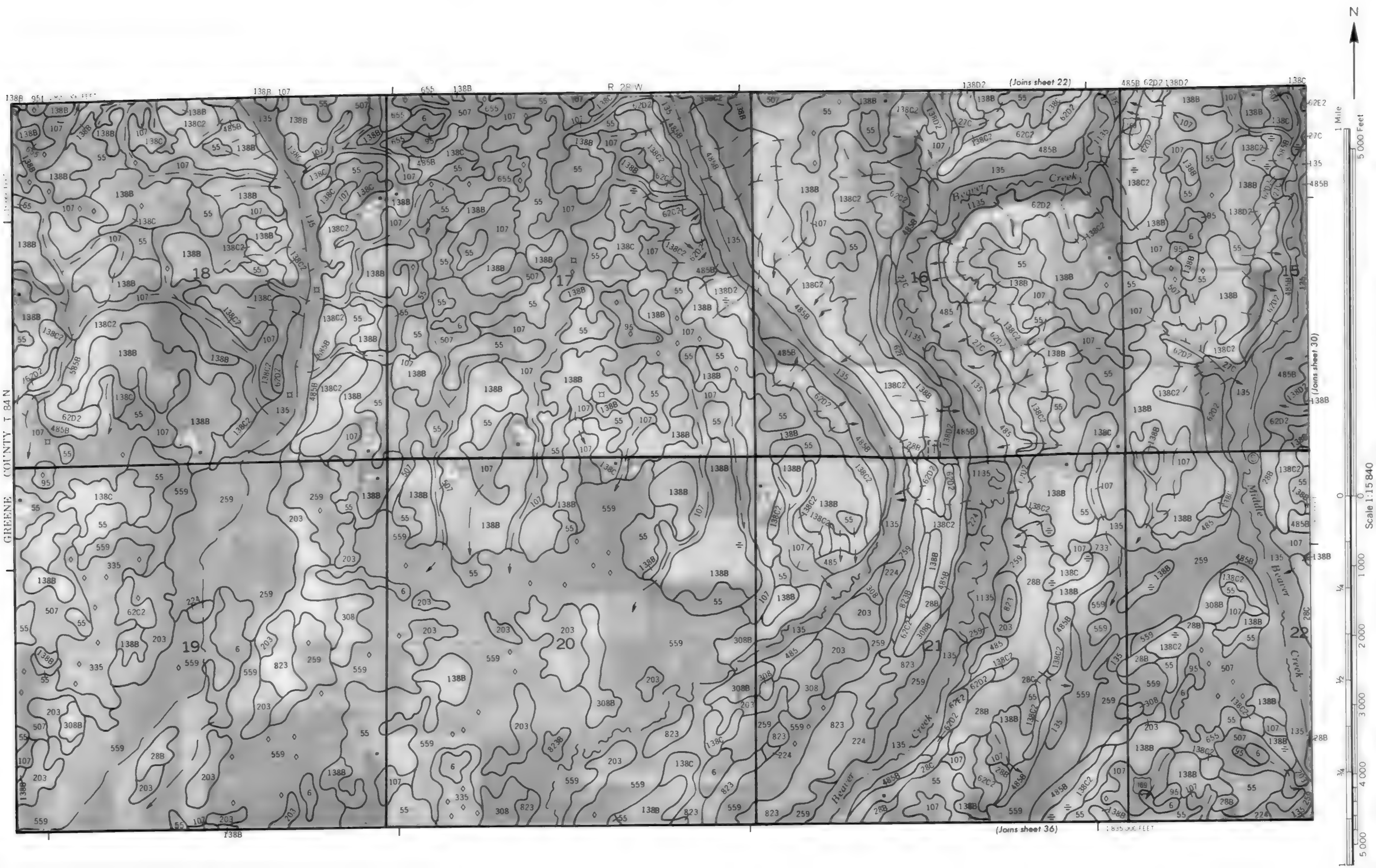

25
N
R. 27 W. | R. 26 W.
(Joins sheet 18)
(Joins sheet 24)
(Joins sheet 26)
(Joins sheet 32)
T. 84 N.
DES MOINES RIVER
SAYLORVILLE RESERVOIR
CHICAGO AND NORTH WESTERN
FLOOD POOL LINE
1 Mile
5 000 Feet
Scale 1:15 840


N
Scale 1:15 840
1 Mile
5 000 Feet
(Joins sheet 19)
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 33)
R. 26 W.
T. 84 N.
Creek


N
R. 26 W. | R. 25 W.
(Joins sheet 20)
(Joins sheet 26)
(Joins sheet 28)
(Joins sheet 34)
T. 84 N.
Prairie Creek
1 Mile
5 000 Feet
Scale 1:15 840

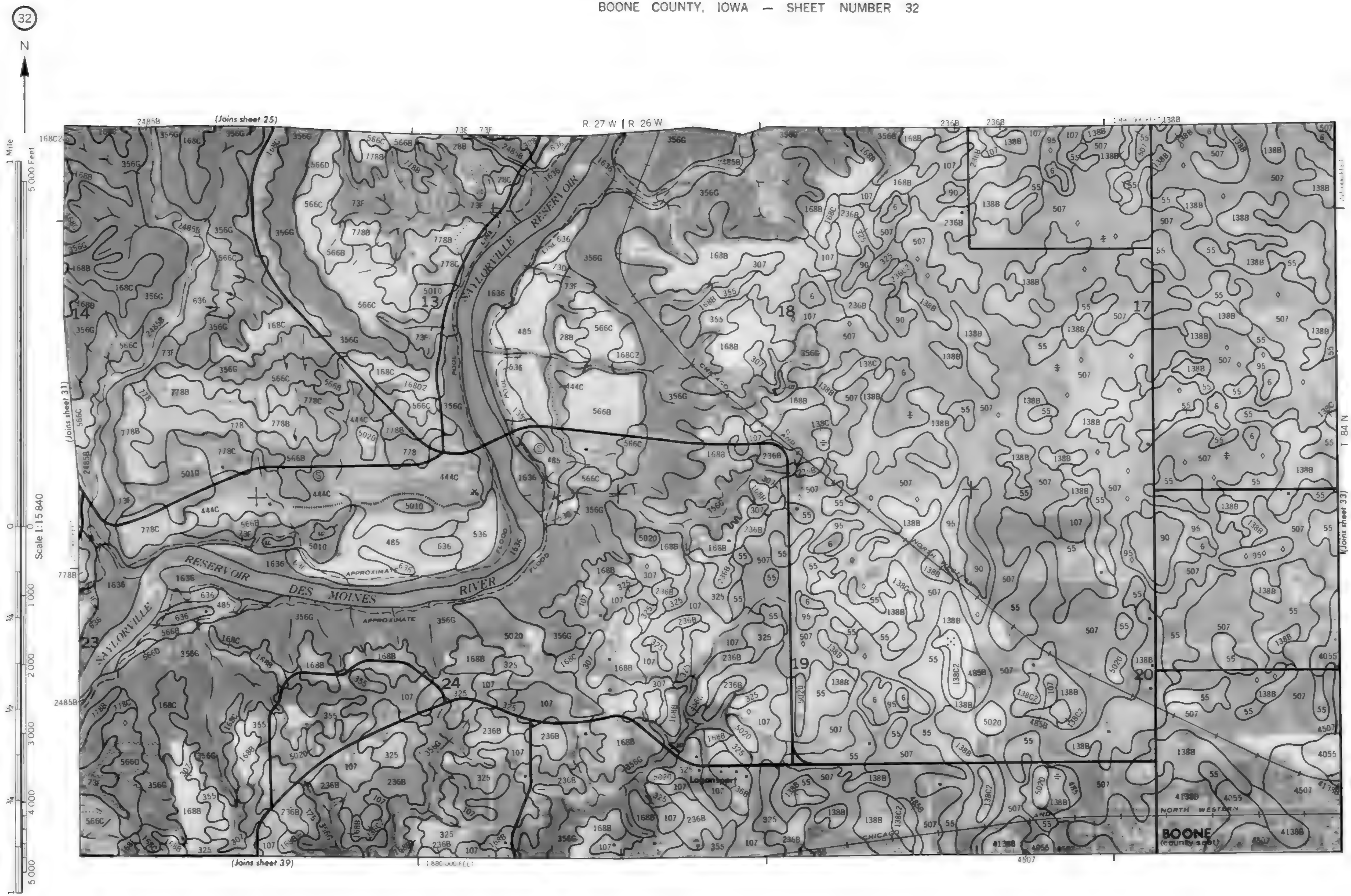
BOONE COUNTY, IOWA — SHEET NUMBER 28

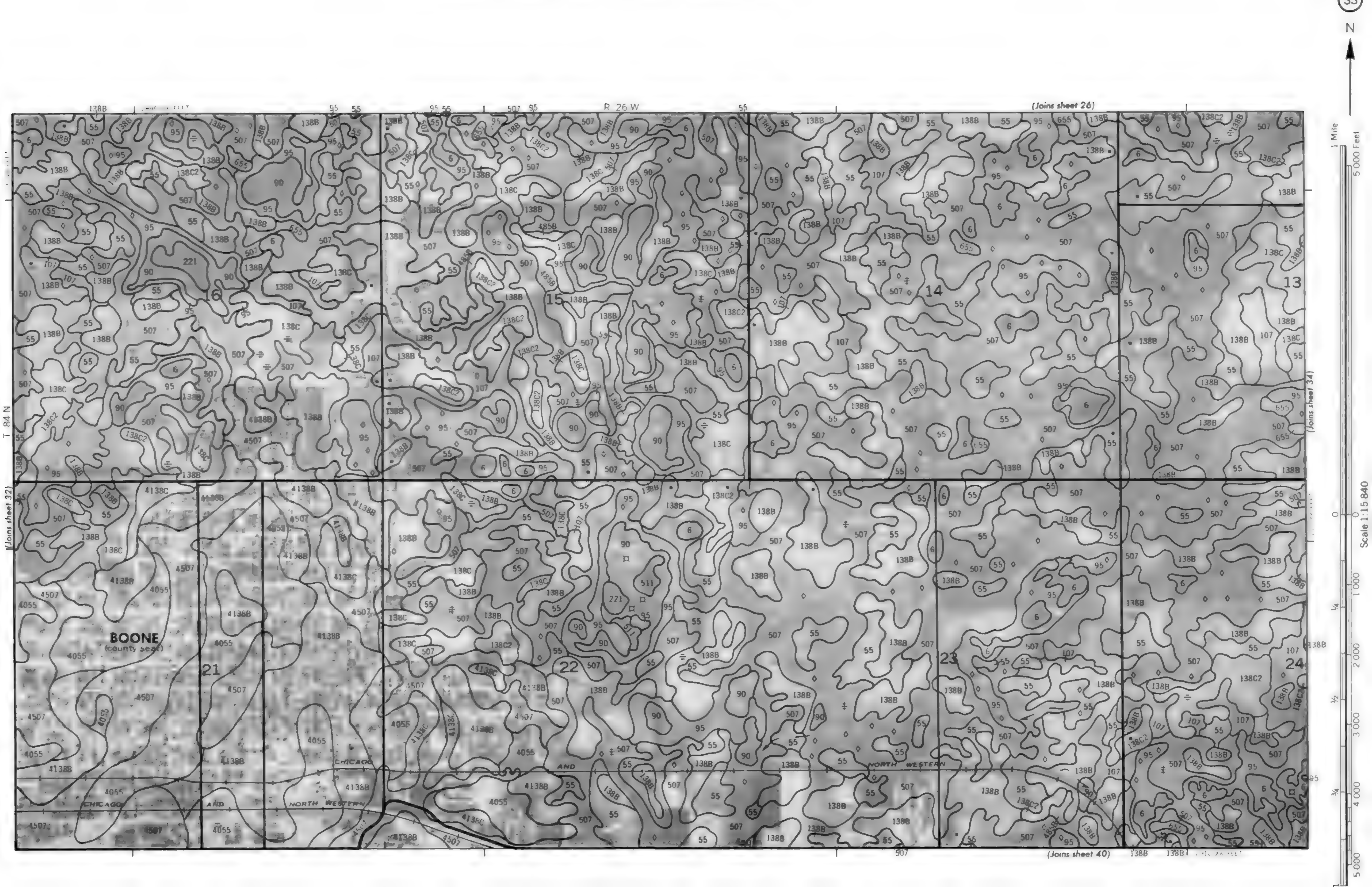



N
(Joins sheet 22)
R 28 W
(Joins sheet 30)
(Joins sheet 36)
GREENE COUNTY
T 84 N
18
17
16
15
19
20
21
22
Beaver Creek
Middle Beaver Creek
Beaver Creek
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5 000
¼
½
¾

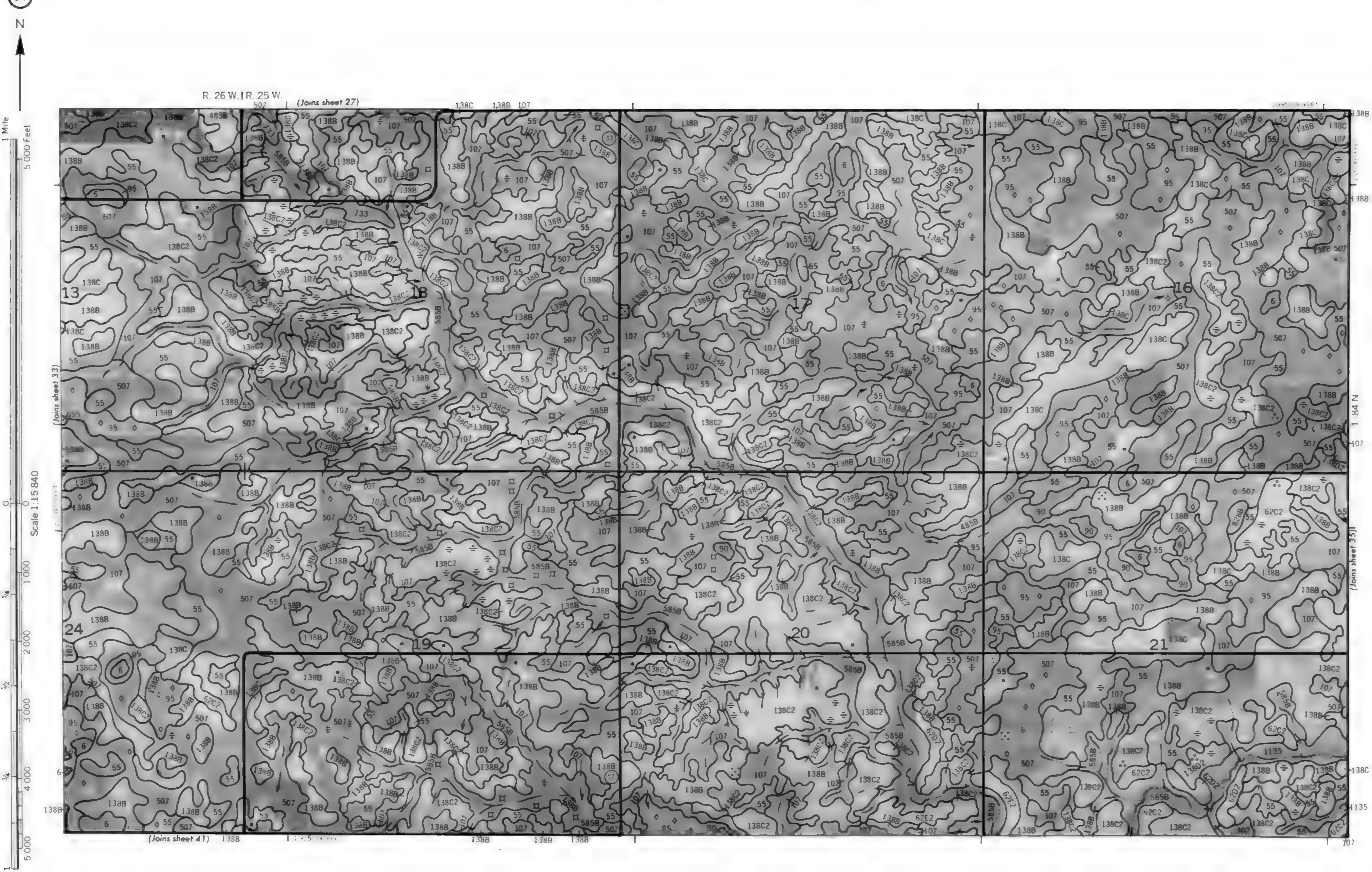

N
(Joins sheet 23)
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 37)
R 28 W | R 27 W
T 84 N
Scale 1:15 840
1 Mile
5 000 Feet
East Beaver Creek

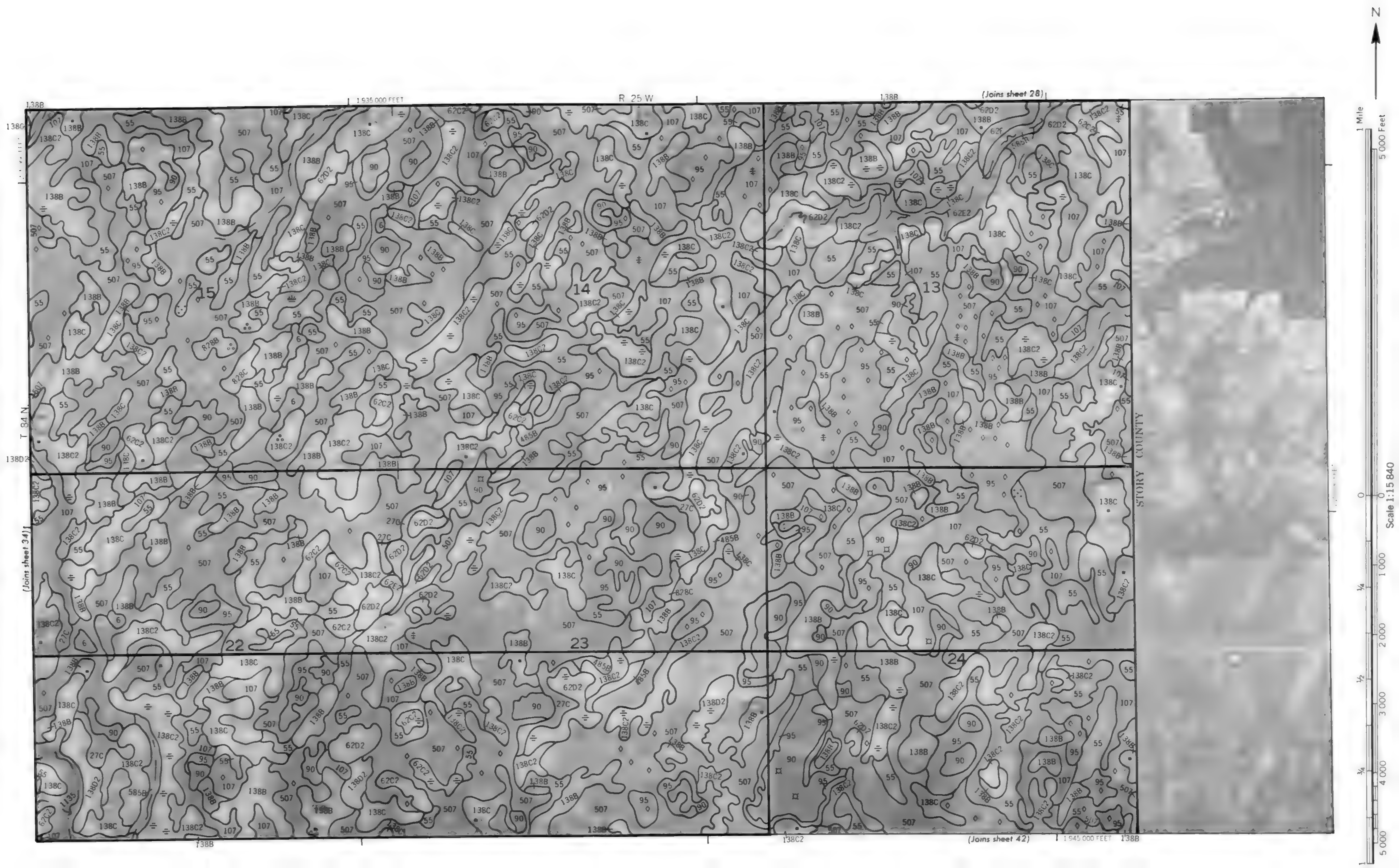

N
(Joins sheet 24)
(Joins sheet 30)
(Joins sheet 32)
(Joins sheet 38)
R. 27 W.
T. 84 N.
Creek
Bluff
water
DES MOINES RIVER
Saylorville Reservoir
APPROXIMATE FLOOD POOL LINE
17
16
15
14
20
21
22
23
1 Mile
5 000 Feet
Scale 1:15 840


32
N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 25)
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 39)
R. 27 W | R. 26 W
T. 84 N.
SAYLORVILLE RESERVOIR
DES MOINES RIVER
FLOOD POOL LINE
APPROXIMATE
CHICAGO AND NORTH WESTERN
Logansport
BOONE (county seat)
1 880 000 FEET

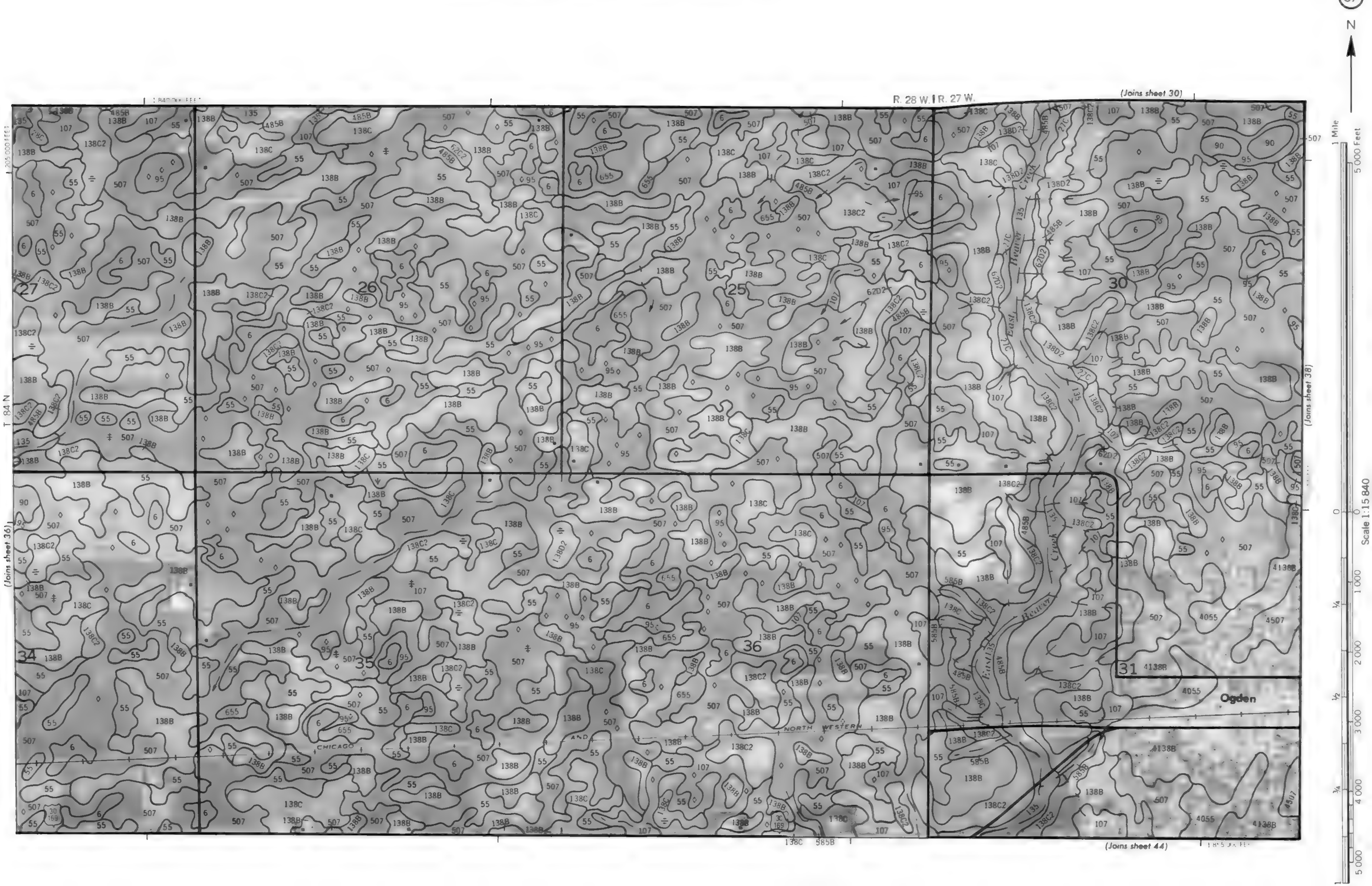

33
N
(Joins sheet 26)
R 26 W
T 84 N
(Joins sheet 32)
(Joins sheet 34)
(Joins sheet 40)
BOONE
(county seat)
CHICAGO AND NORTH WESTERN
15
14
13
21
22
23
24
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾

BOONE COUNTY, IOWA — SHEET NUMBER 34

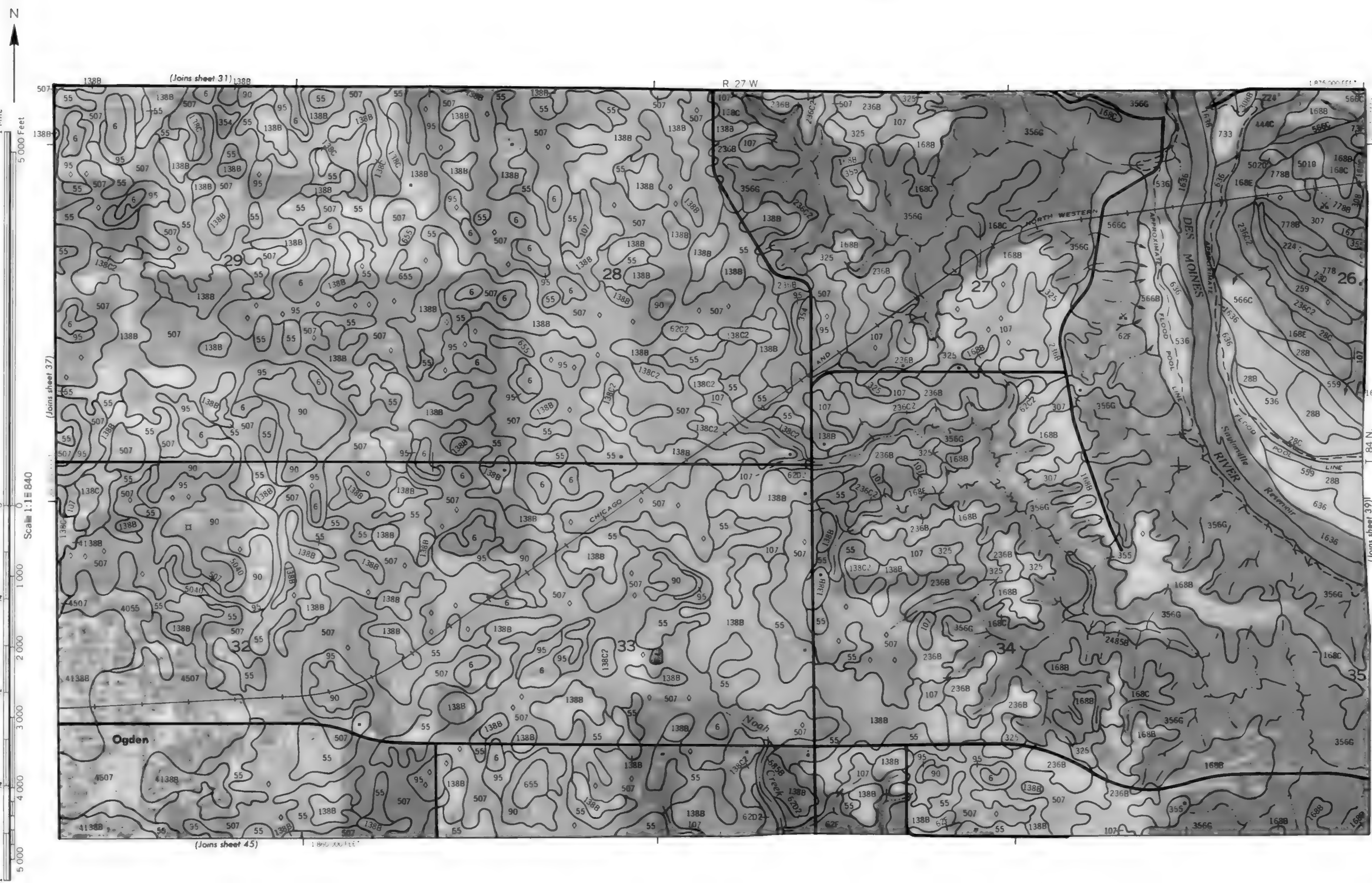


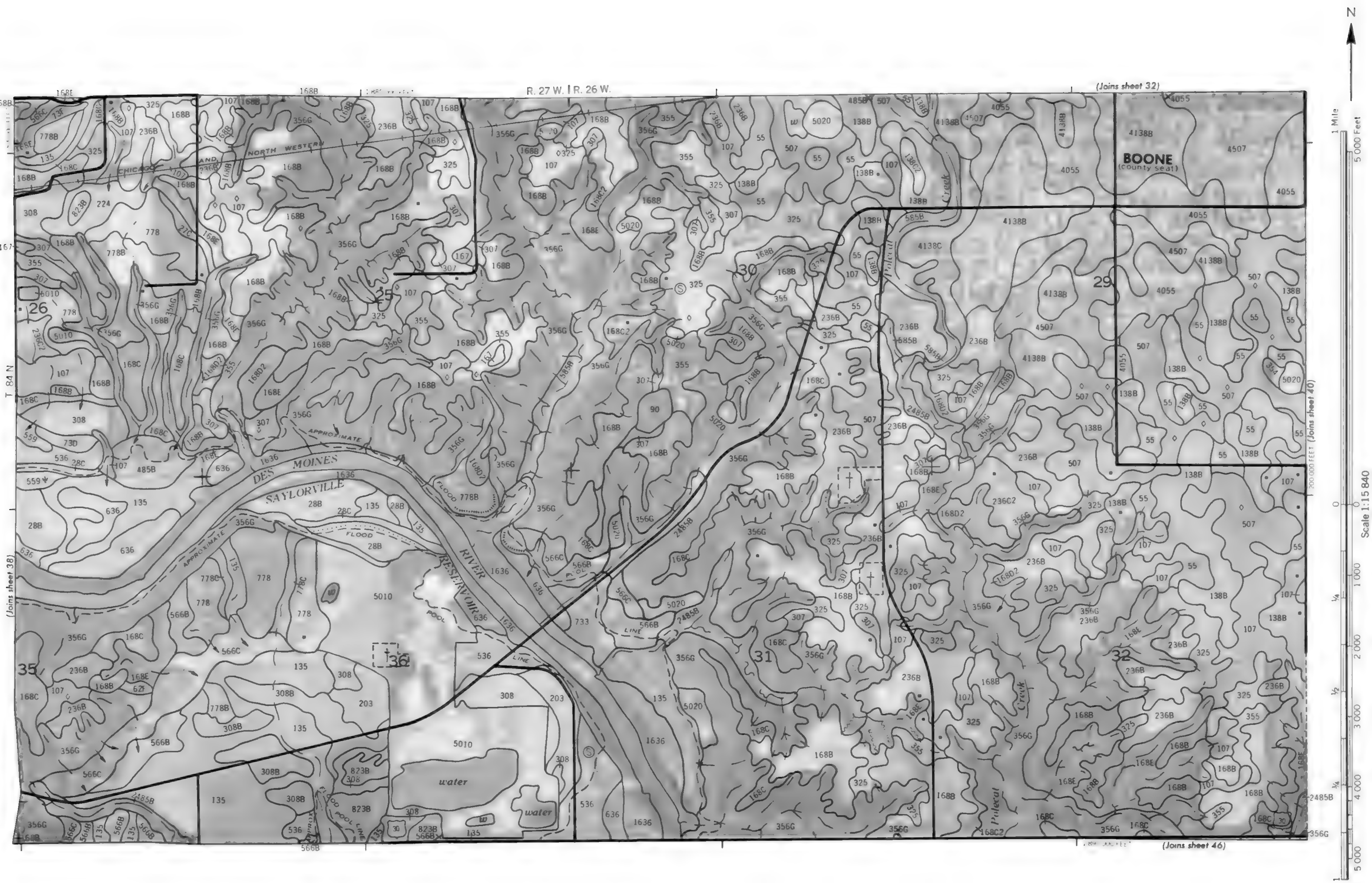

N
(Joins sheet 28)
R 25 W
1 935 000 FEET
T 84 N
(Joins sheet 34)
STORY COUNTY
(Joins sheet 42)
1 945 000 FEET
15
14
13
22
23
24
1 Mile
5 000 Feet
Scale 1:15 840
0
¼
½
¾
1 000
2 000
3 000
4 000
5 000


N
(Joins sheet 29)
R 28 W
(Joins sheet 37)
(Joins sheet 43)
GREENE COUNTY
T 84 N.
1 Mile
5 000 Feet
Scale 1:15 840
1 820 000 FEET
Beaver Creek
Middle Beaver Creek
Beaver
CHICAGO AND NORTH WESTERN
30
29
28
27
31
32
33
34

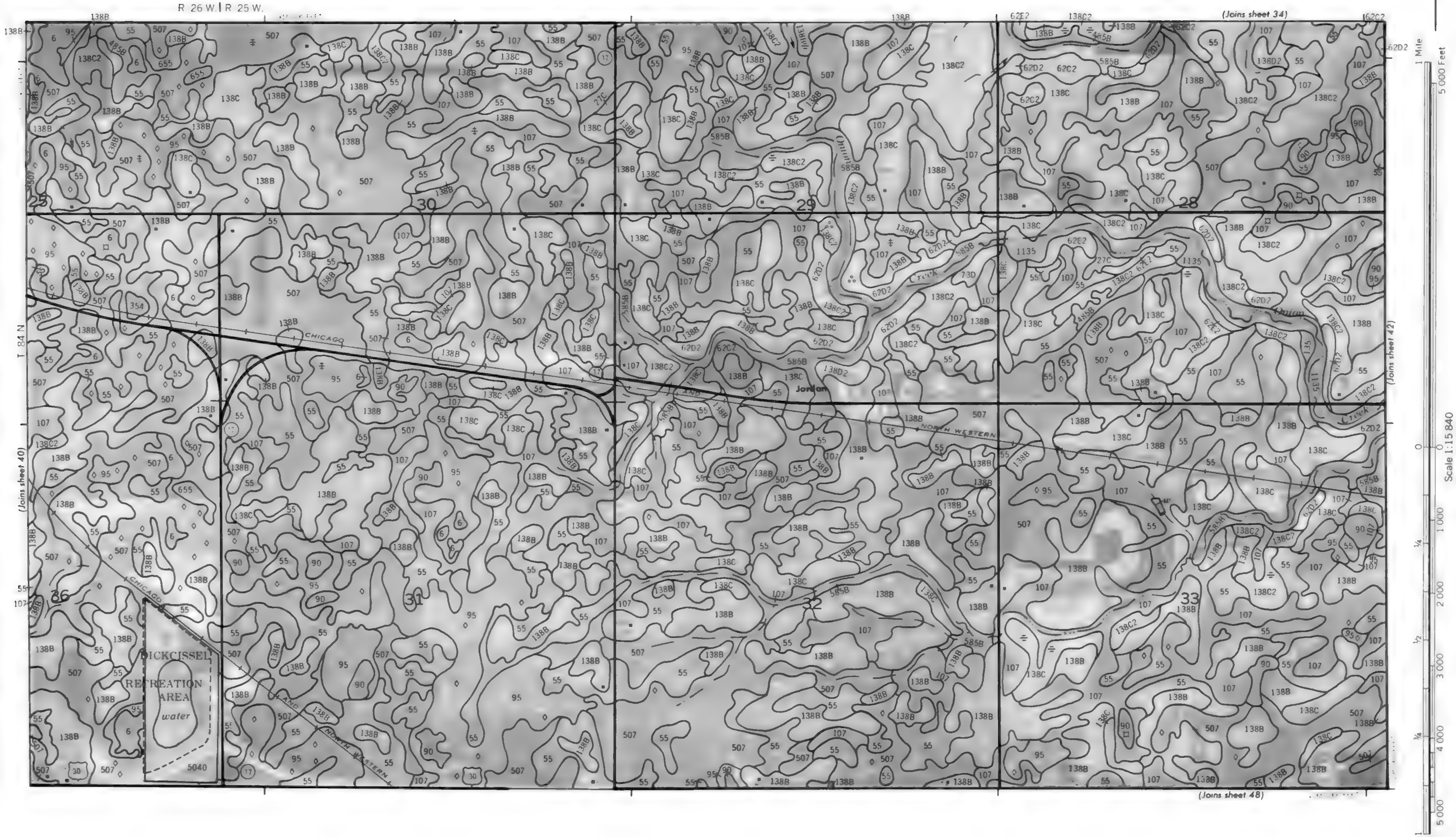

37
N
(Joins sheet 30)
R. 28 W. | R. 27 W.
(Joins sheet 38)
(Joins sheet 36)
(Joins sheet 44)
T. 84 N.
27
26
25
30
34
35
36
31
Ogden
East Beaver Creek
CHICAGO AND NORTH WESTERN
1 Mile
Scale 1:15 840
5 000 Feet

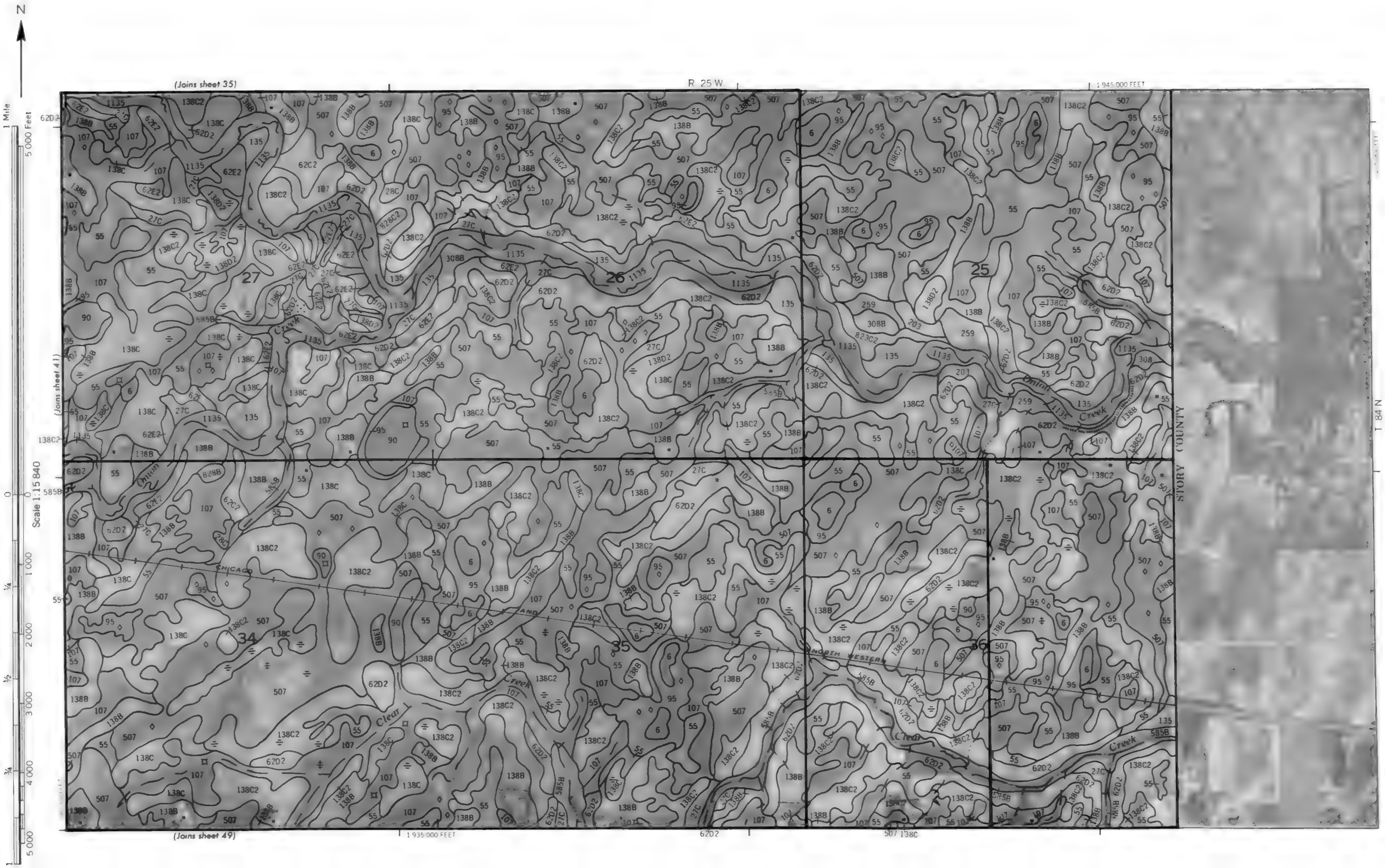
BOONE COUNTY, IOWA — SHEET NUMBER 38

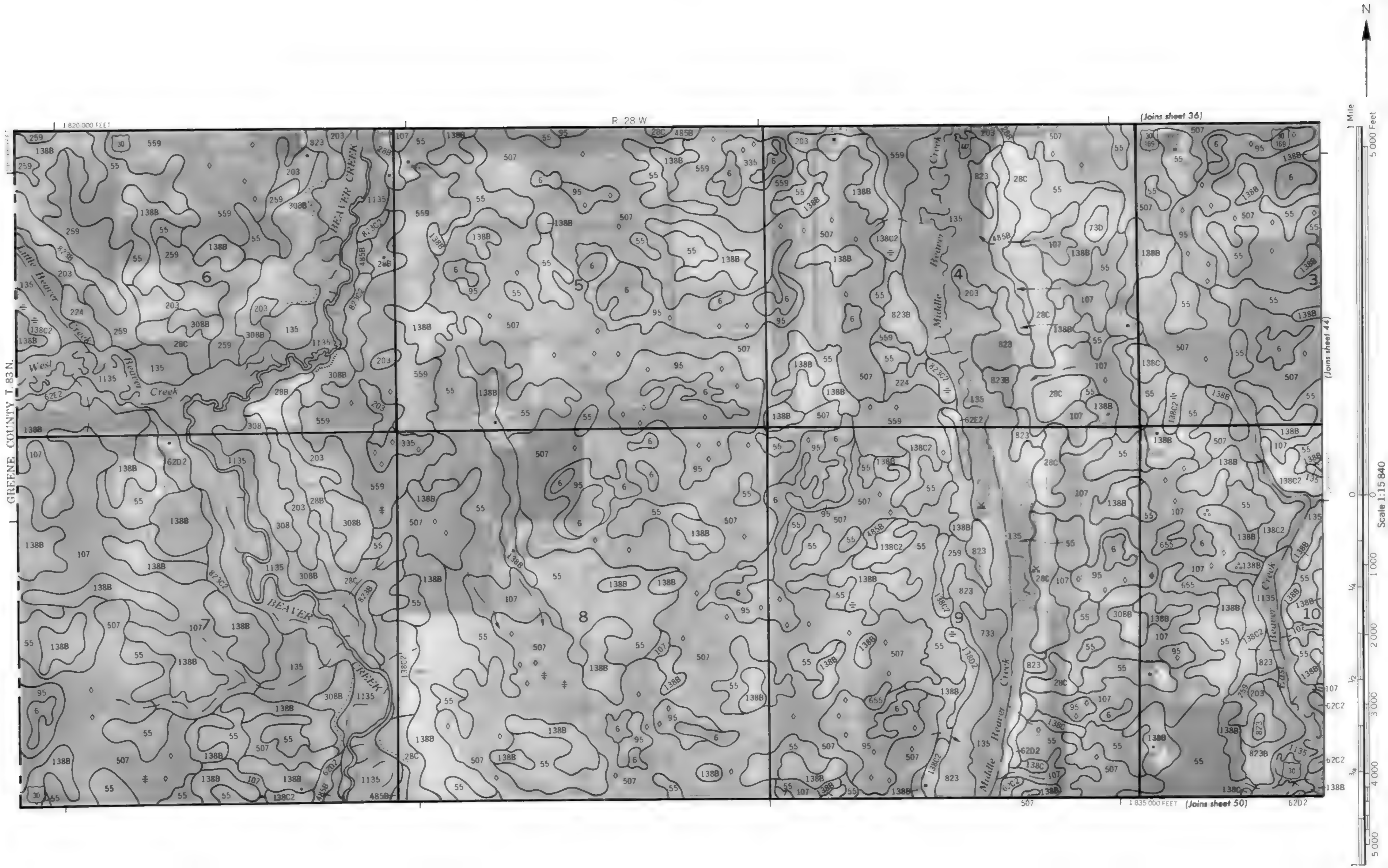


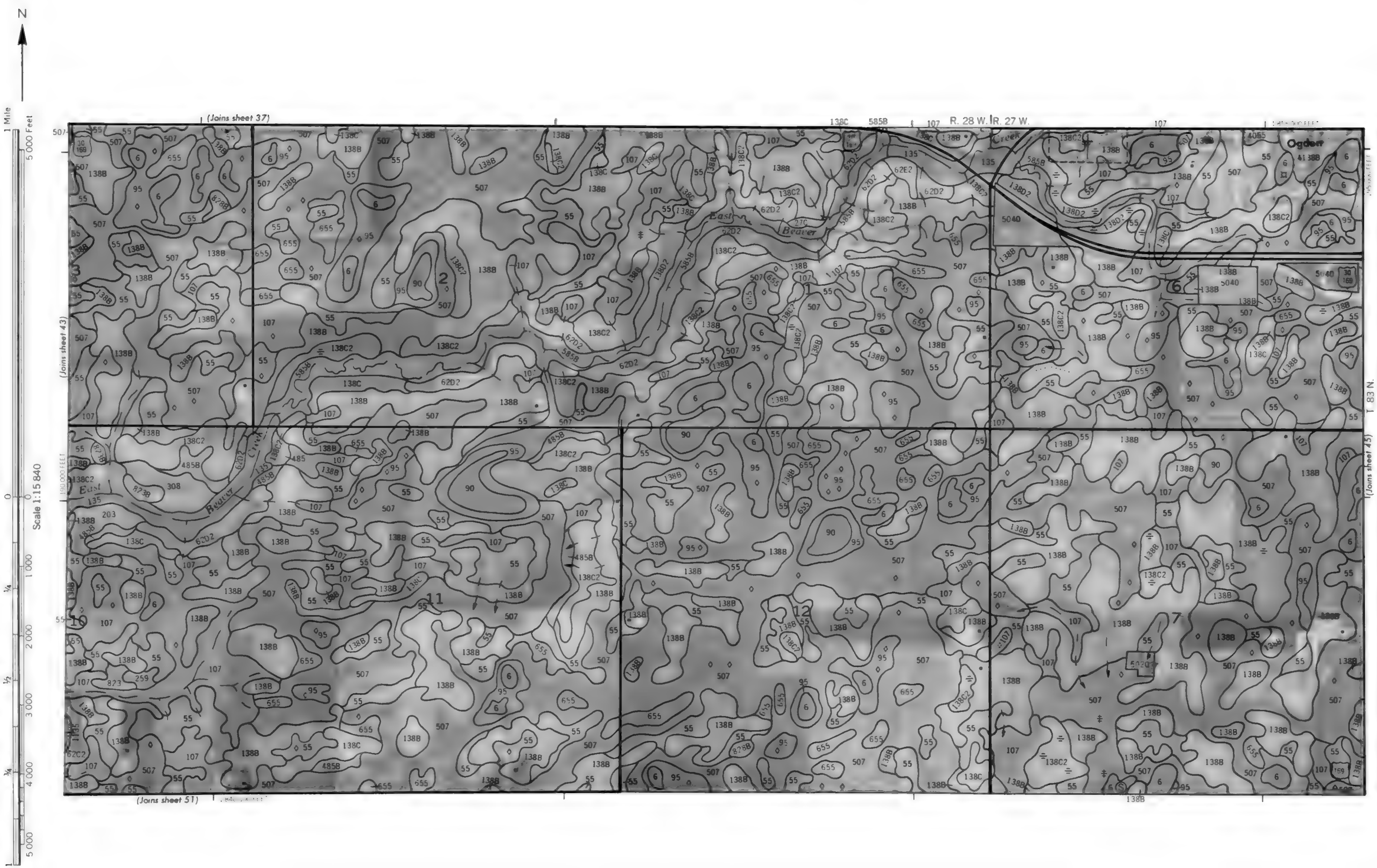

N
R. 27 W. | R. 26 W.
(Joins sheet 32)
(Joins sheet 40)
(Joins sheet 46)
(Joins sheet 38)
T 84 N
BOONE
(county seat)
CHICAGO AND NORTH WESTERN
DES MOINES RIVER
SAYLORVILLE RESERVOIR
APPROXIMATE FLOOD POOL LINE
Polecat Creek
water
25
26
29
30
31
32
35
36
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

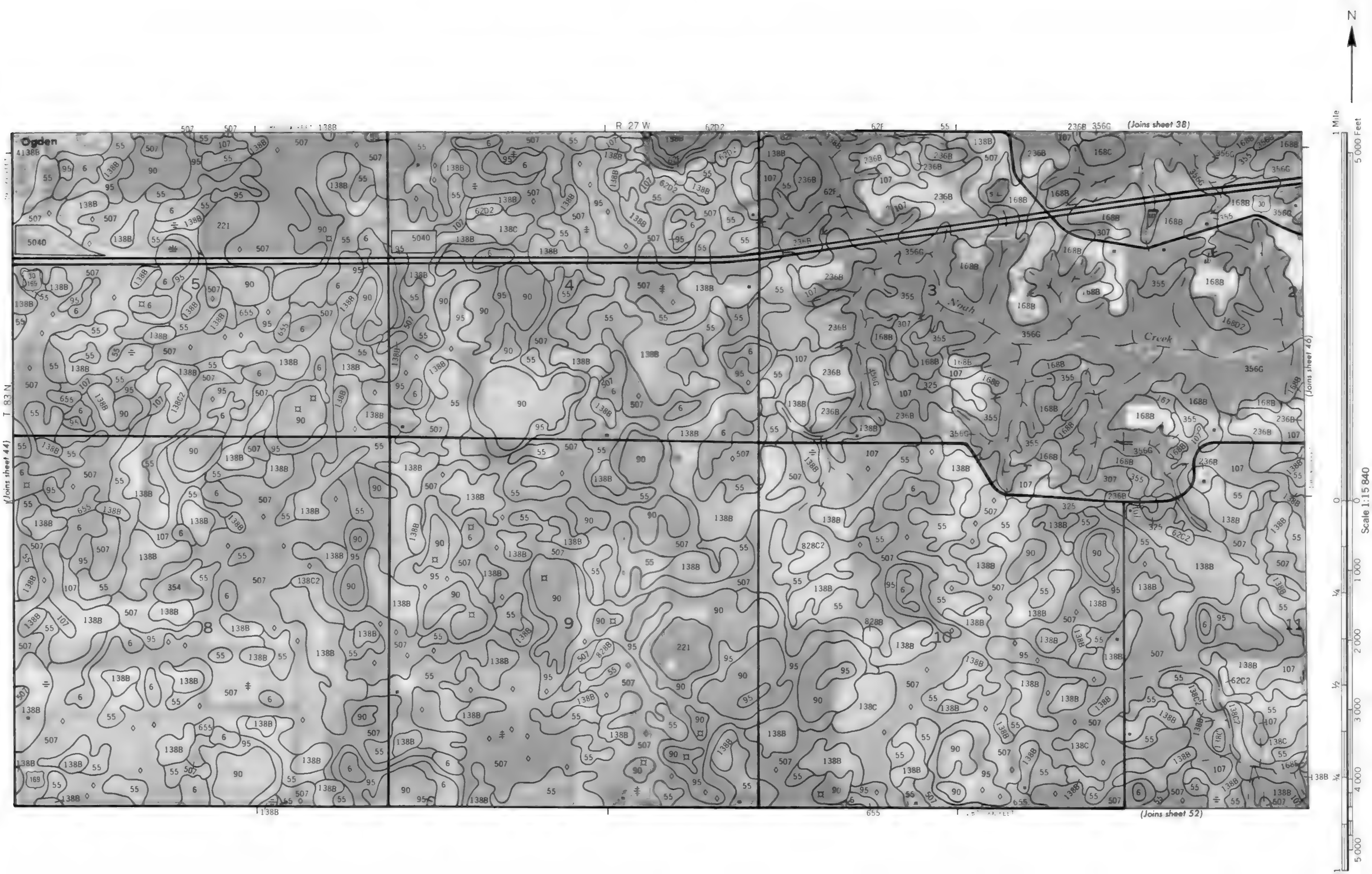

40
N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 33)
(Joins sheet 39)
(Joins sheet 41)
(Joins sheet 47)
R 26 W
T 84 N.
1 895 000 FEET
BOONE
(county seat)
BOONE
MUNICIPAL
AIRPORT
McHOSE PARK
CHICAGO
AND
NORTH WESTERN
C AND NW
Honey
Creek
Big Creek
27
28
26
25
33
34
35
36


N
R 26 W. | R 25 W.
T 84 N
(Joins sheet 34)
(Joins sheet 42)
(Joins sheet 48)
(Joins sheet 40)
CHICAGO AND NORTH WESTERN
Jordan
Quinn Creek
DICKCISSEL RECREATION AREA
water
25
30
29
28
36
31
32
33
1 Mile
5 000 Feet
Scale 1:15 840

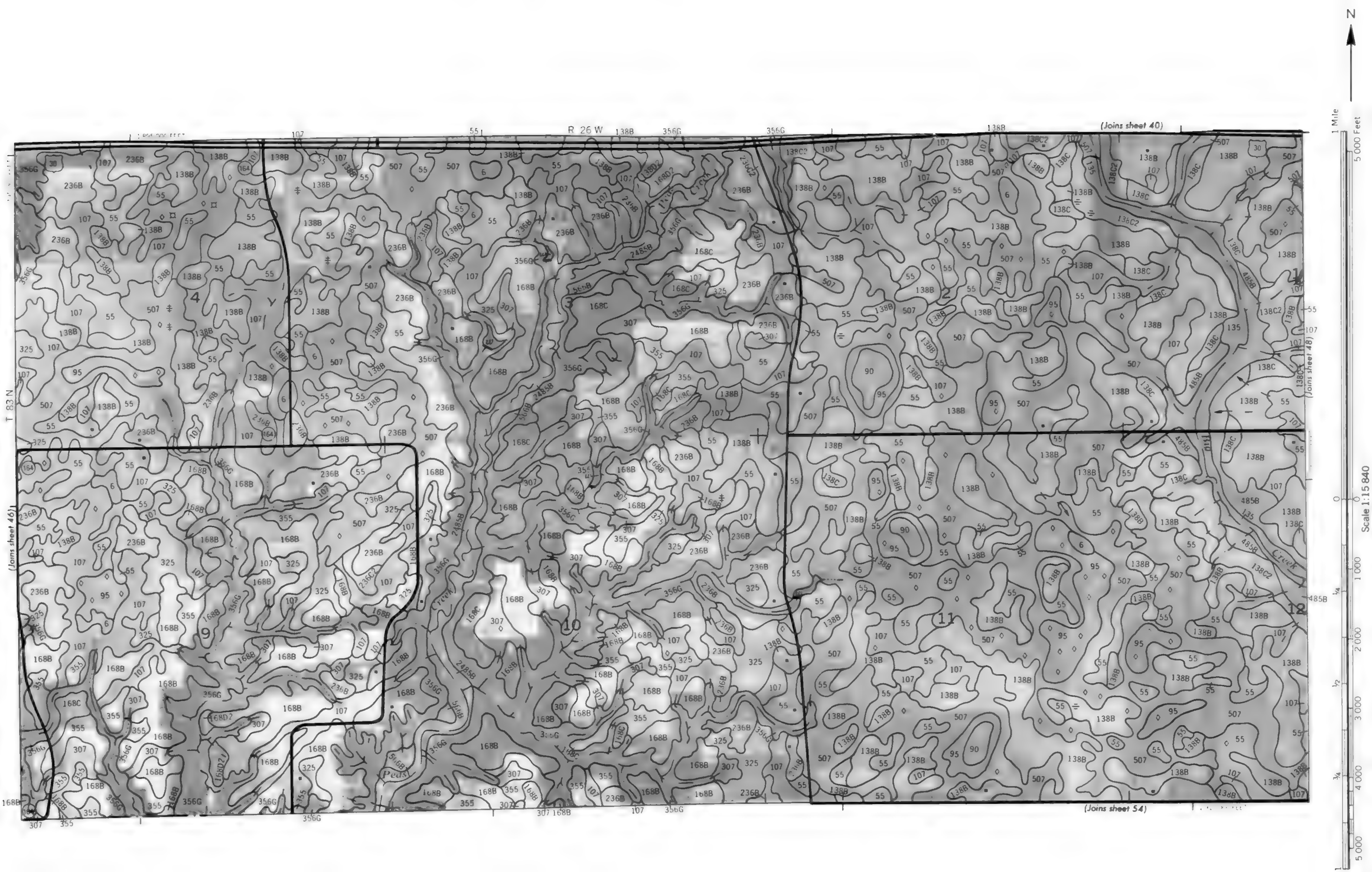

N
(Joins sheet 35)
R 25 W
1 945 000 FEET
(Joins sheet 41)
(Joins sheet 49)
1 935 000 FEET
STORY COUNTY
T 84 N
27
26
25
34
35
36
Onion Creek
Clear Creek
CHICAGO
NORTH WESTERN
Scale 1:15 840
1 Mile
5 000 Feet

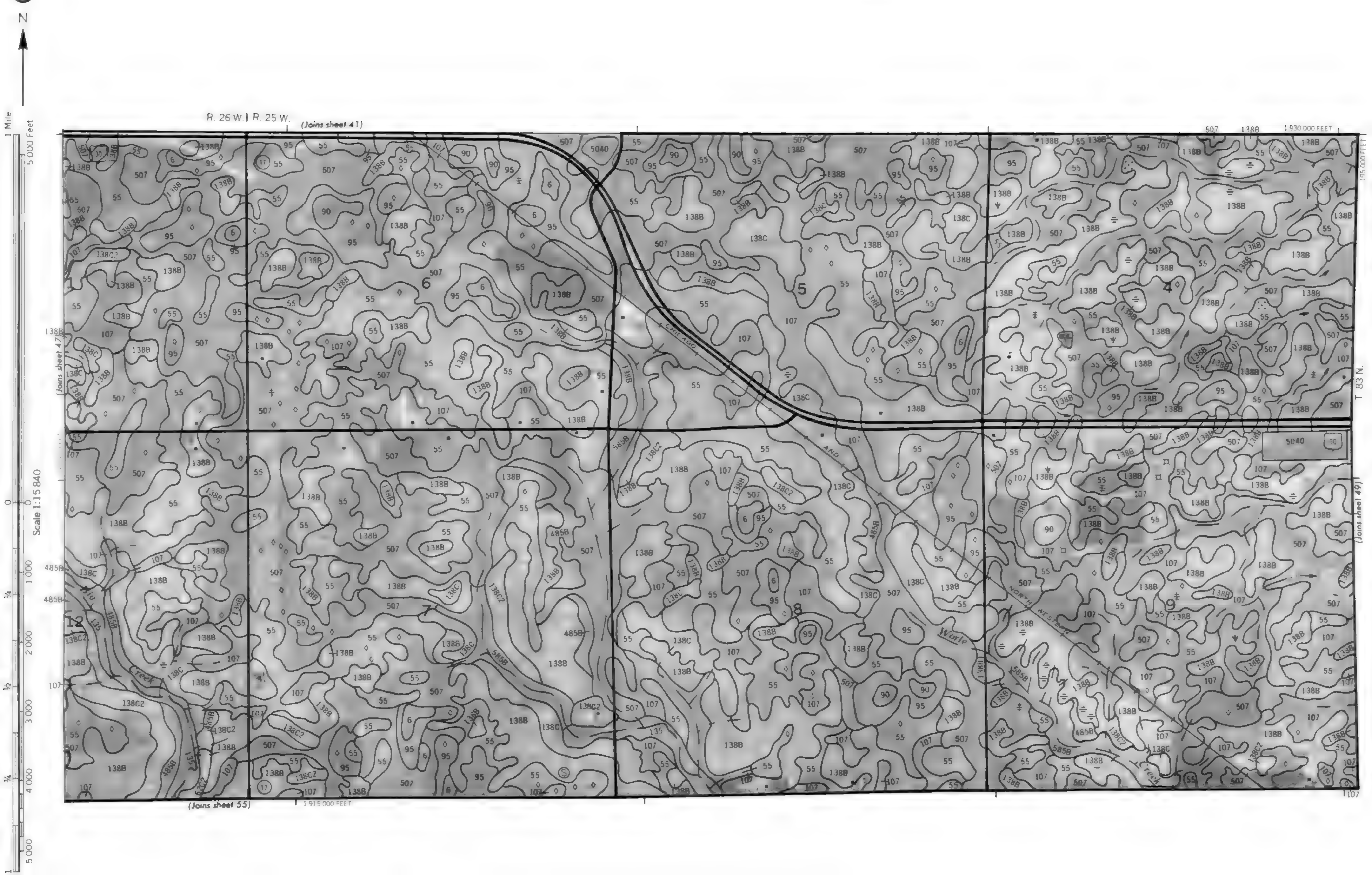

N
R. 28 W.
1 820 000 FEET
(Joins sheet 36)
(Joins sheet 44)
1 835 000 FEET
(Joins sheet 50)
GREENE COUNTY
T. 83 N.
Little Beaver Creek
West Beaver Creek
BEAVER CREEK
Middle Beaver Creek
Beaver Creek
6
5
4
3
7
8
9
10
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

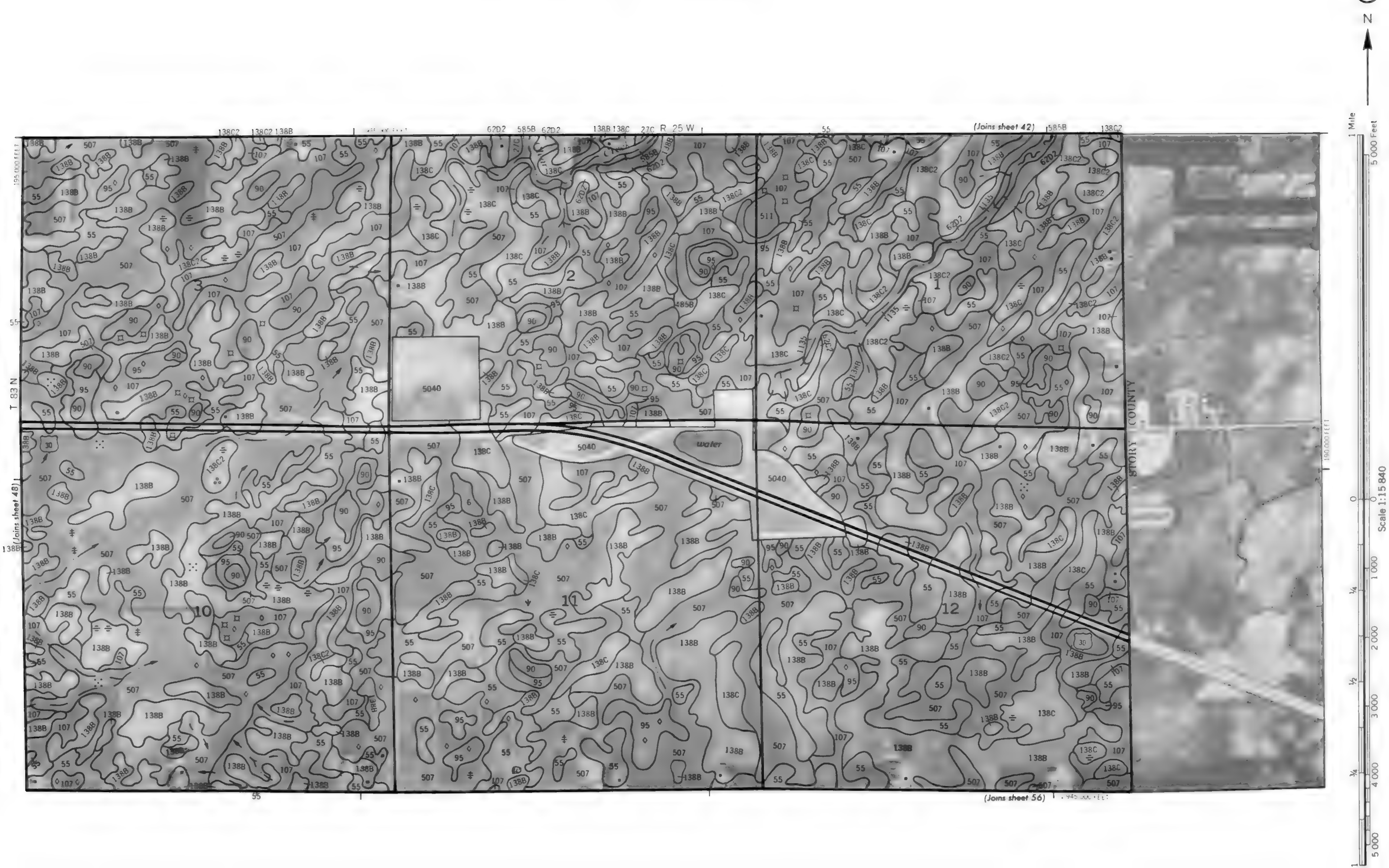

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 37)
(Joins sheet 43)
(Joins sheet 45)
(Joins sheet 51)
R. 28 W.
R. 27 W.
T. 83 N.
Ogden
East Beaver Creek
Beaver
Creek

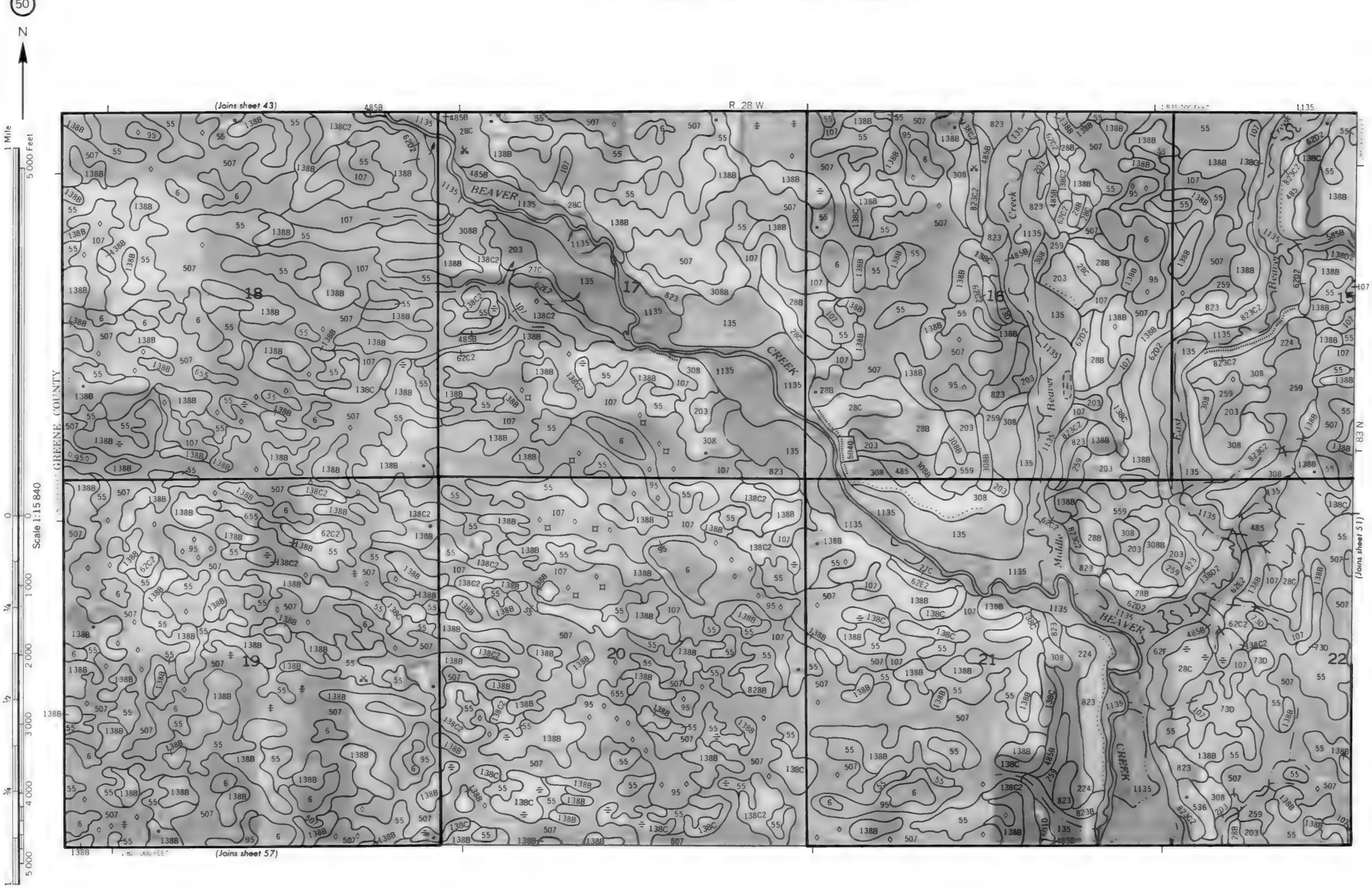

N
Ogden
R 27 W
T 83 N
(Joins sheet 38)
(Joins sheet 46)
(Joins sheet 52)
(Joins sheet 44)
Creek
1 Mile
5 000 Feet
Scale 1:15 840

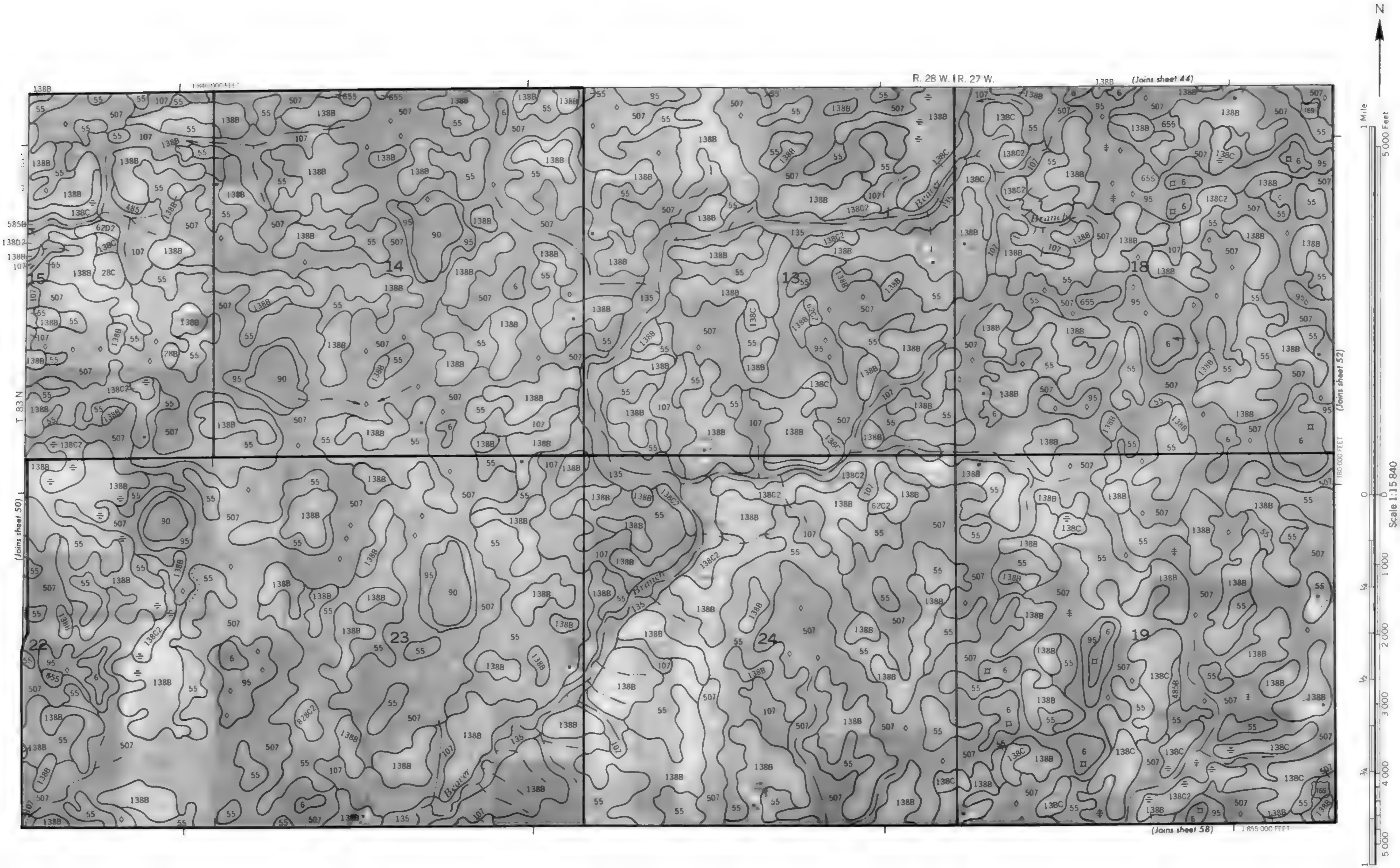

N
(Joins sheet 39)
R. 27 W. | R. 26 W.
SAYLORVILLE RESERVOIR
DES MOINES RIVER
Moingona
Noah Creek
Honey Creek
(Joins sheet 45)
(Joins sheet 47)
(Joins sheet 53)
T. 83 N.
Scale 1:15 840
1 Mile
5 000 Feet

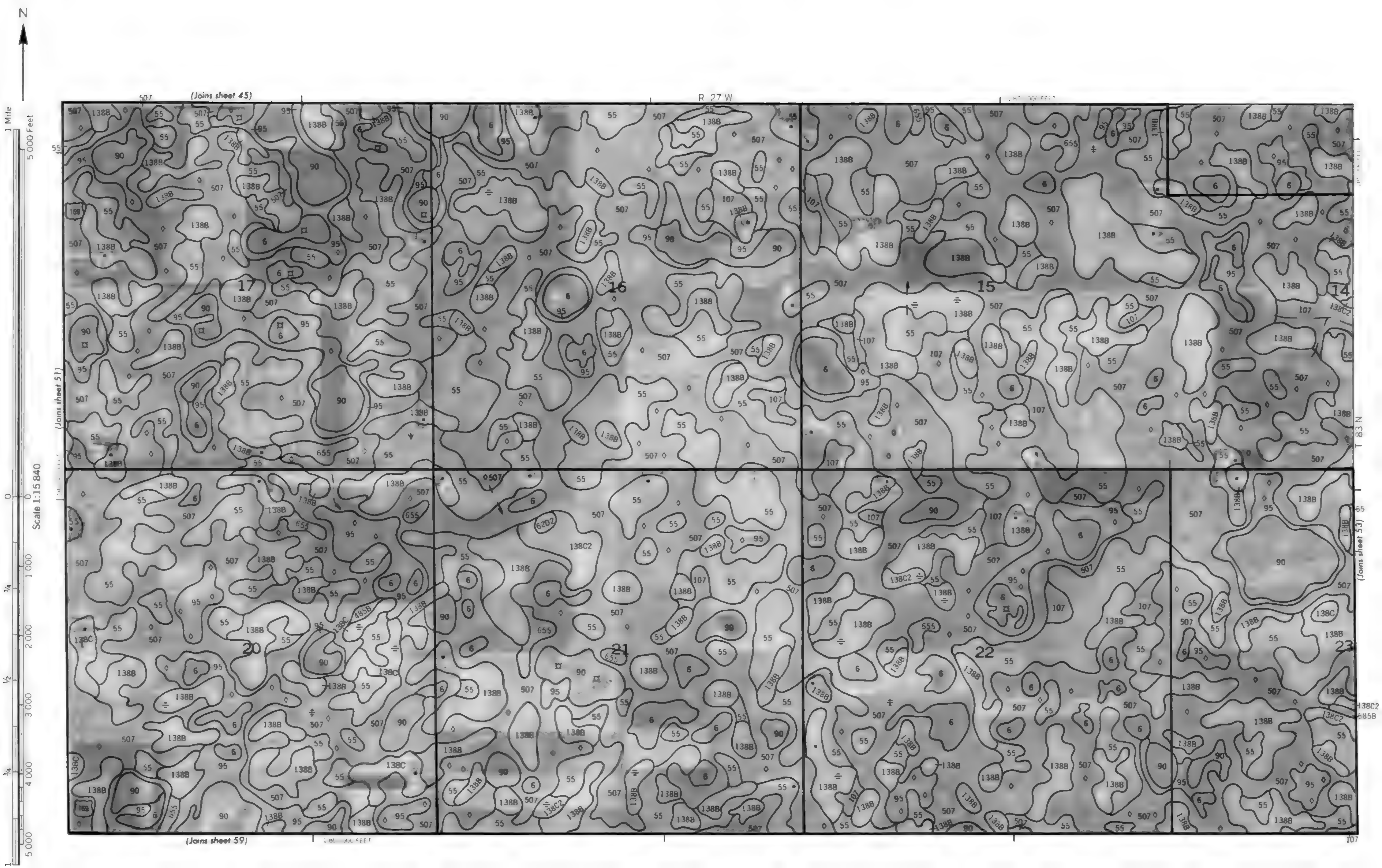

N
(Joins sheet 40)
(Joins sheet 54)
(Joins sheet 46)
(Joins sheet 48)
R 26 W
T 83 N
1 Mile
5 000 Feet
Scale 1:15 840
Creek

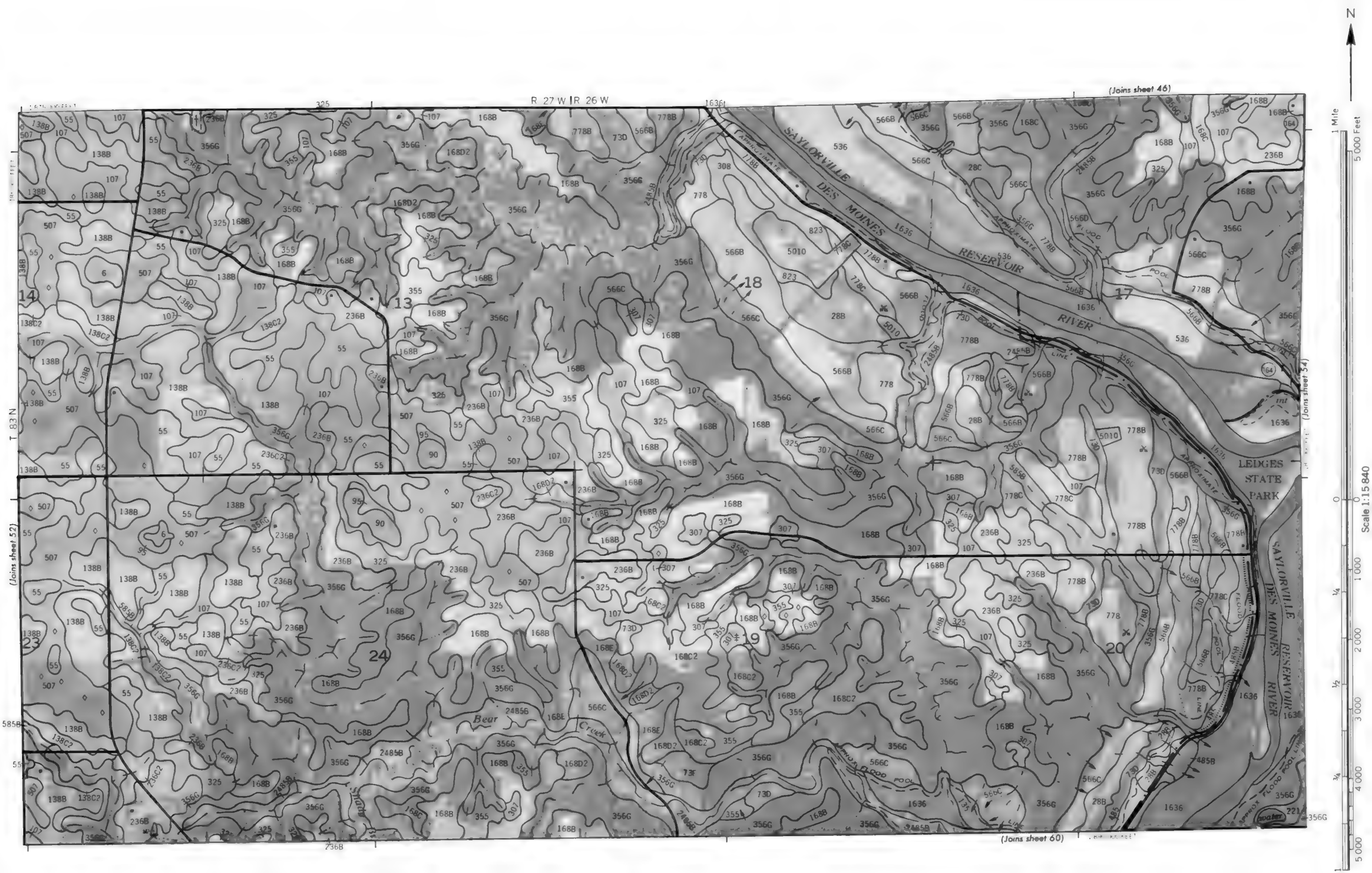

N
R. 26 W. | R. 25 W.
(Joins sheet 41)
(Joins sheet 47)
(Joins sheet 49)
(Joins sheet 55)
T 83 N.
1 930 000 FEET
195 000 FEET
1 915 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840
CHICAGO AND NORTH WESTERN
Worle Creek
Creek

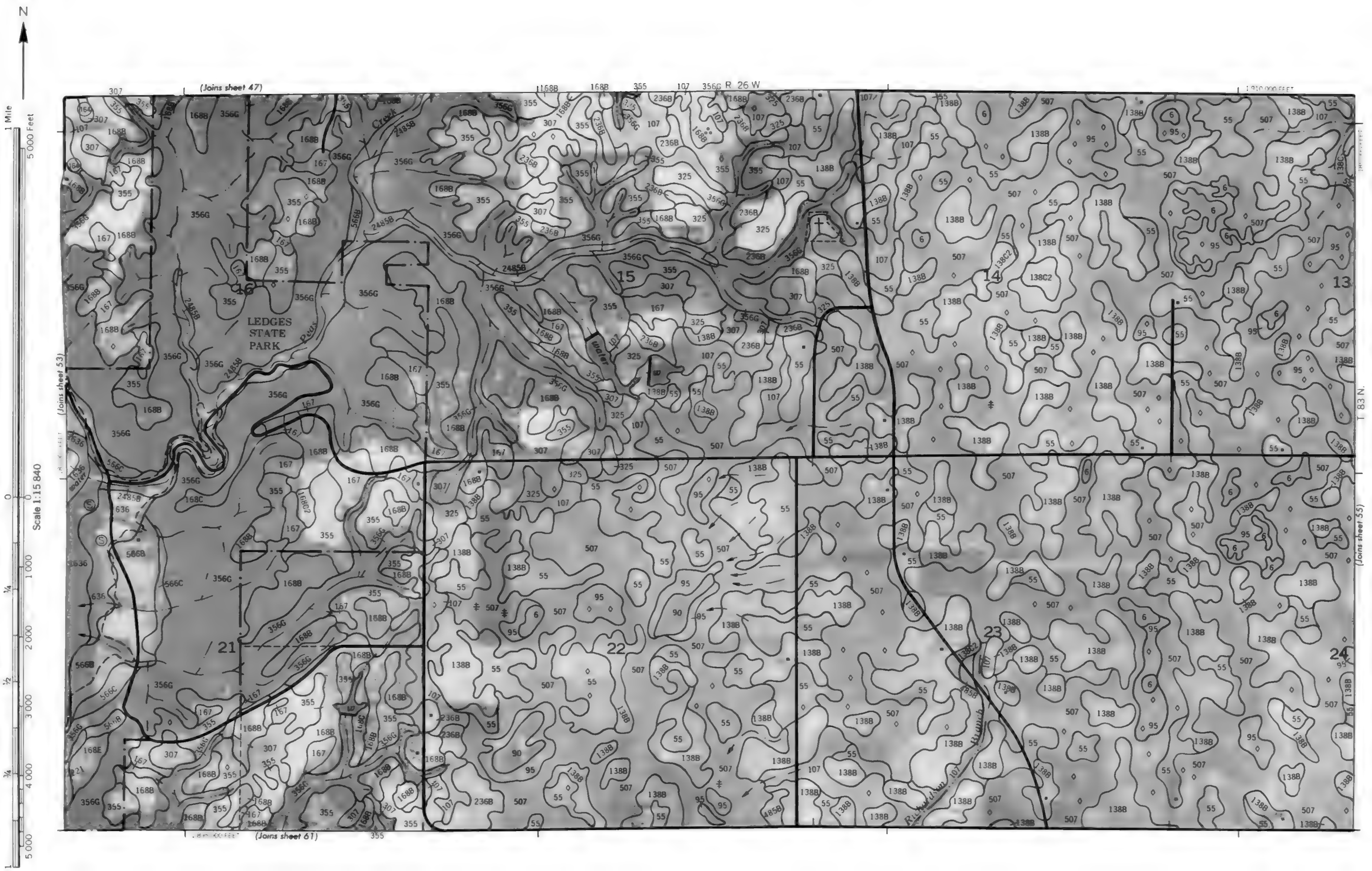

N
(Joins sheet 42)
R. 25 W.
T. 83 N.
(Joins sheet 48)
(Joins sheet 56)
STORY COUNTY
water
Scale 1:15 840
1 Mile
5 000 Feet

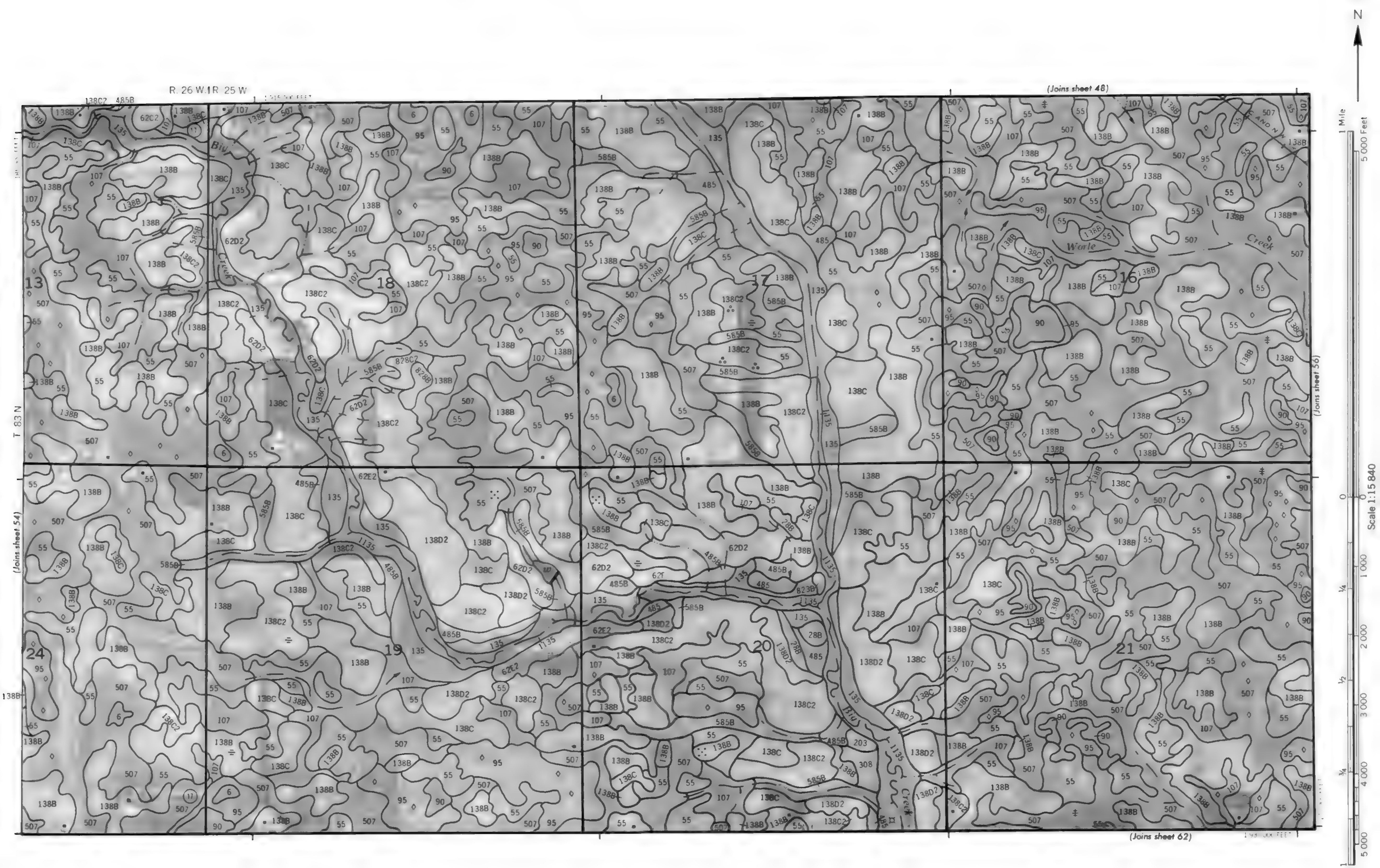

N
(Joins sheet 43)
R. 28 W.
(Joins sheet 51)
(Joins sheet 57)
T 83 N
GREENE COUNTY
BEAVER
CREEK
Beaver
Creek
Middle
East
18
17
16
15
19
20
21
22
1 Mile
5 000 Feet
Scale 1:15 840

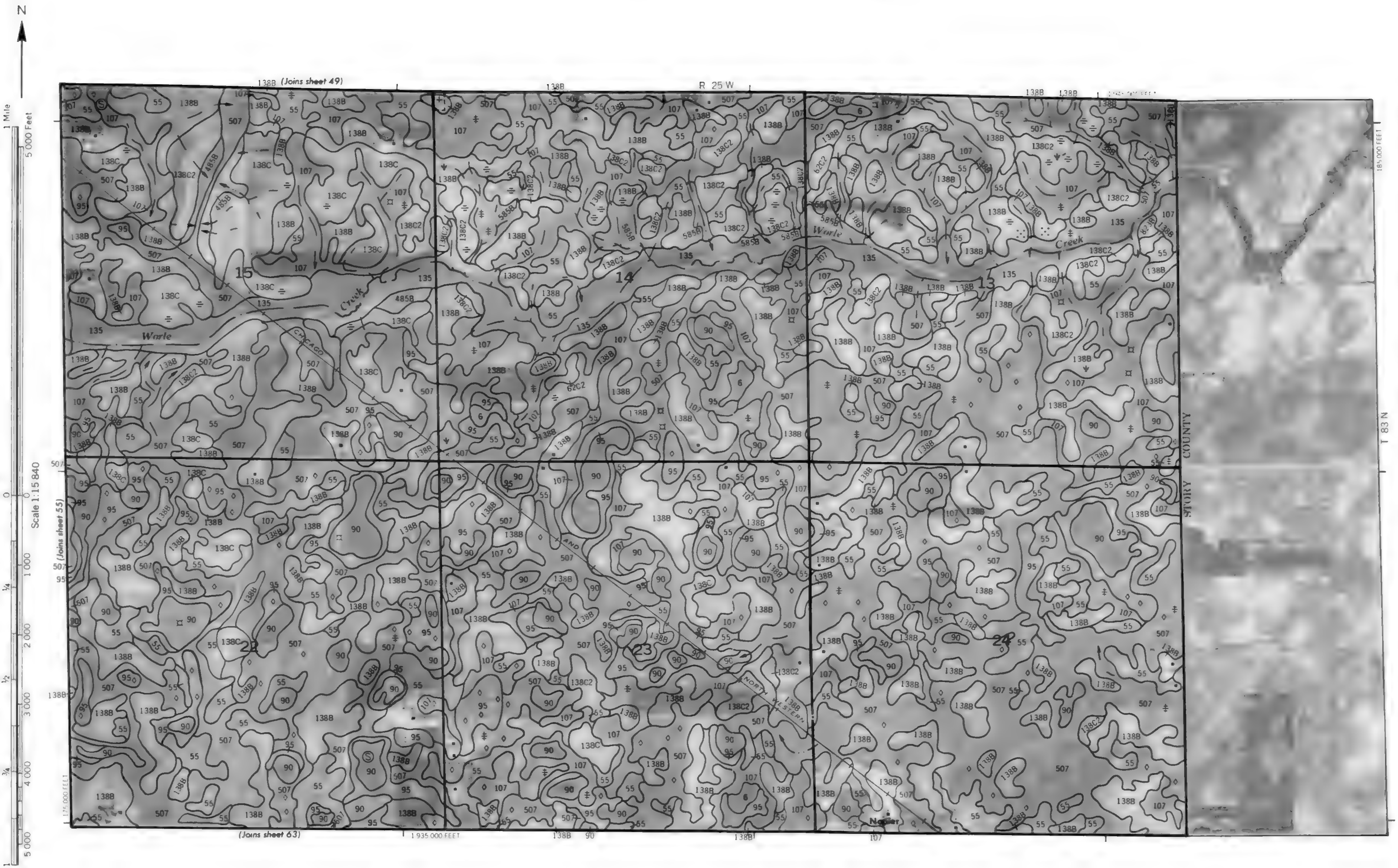

N
R. 28 W. | R. 27 W.
(Joins sheet 44)
(Joins sheet 52)
(Joins sheet 58)
(Joins sheet 50)
T. 83 N.
1 840 000 FEET
1 855 000 FEET
180 000 FEET
14
13
18
15
23
24
19
22
Beaver
Branch
Scale 1:15 840
1 Mile
5 000 Feet
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾

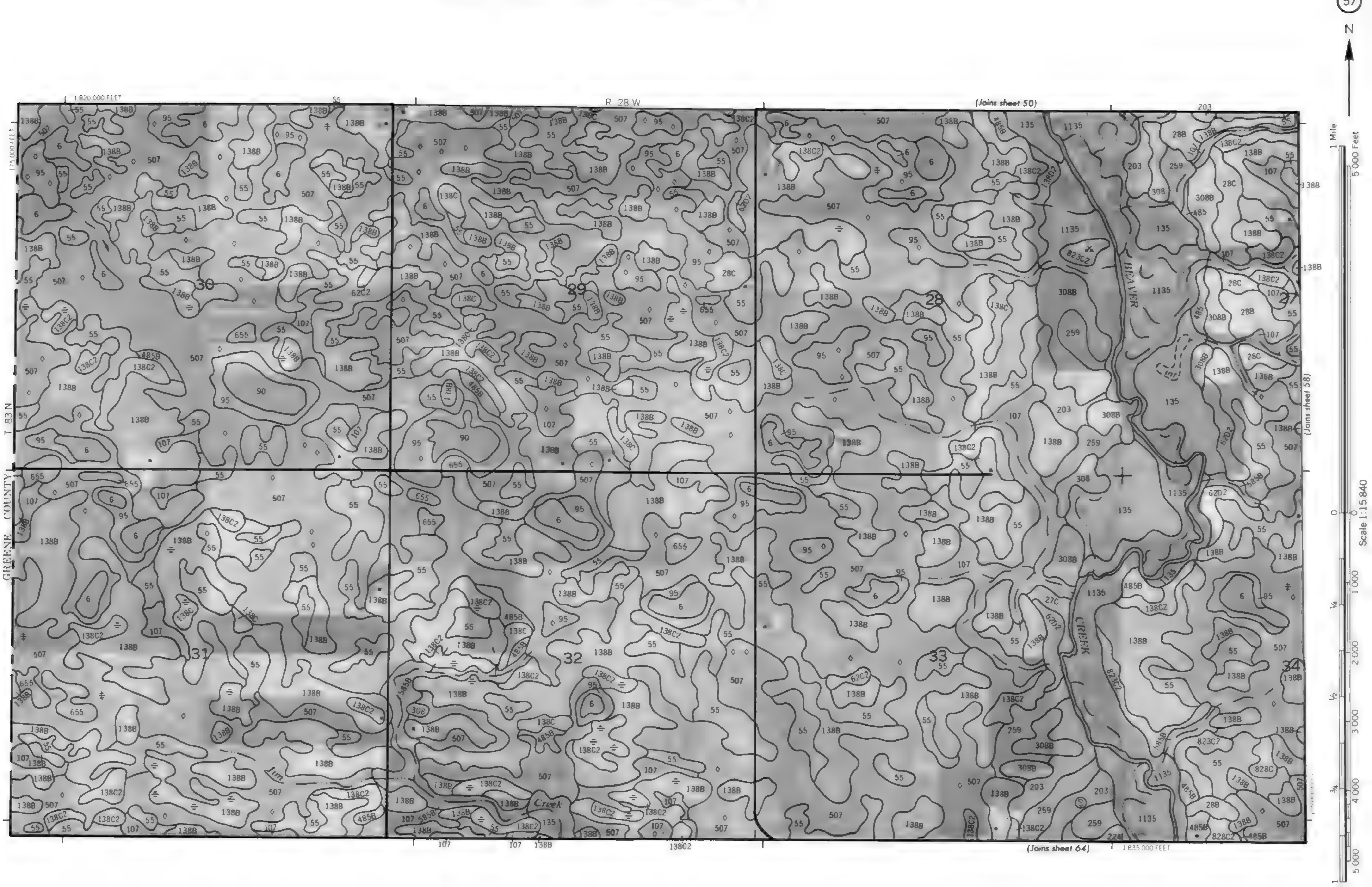

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 45)
R. 27 W.
(Joins sheet 51)
(Joins sheet 53)
(Joins sheet 59)
T. 83 N.
17
16
15
14
20
21
22
23

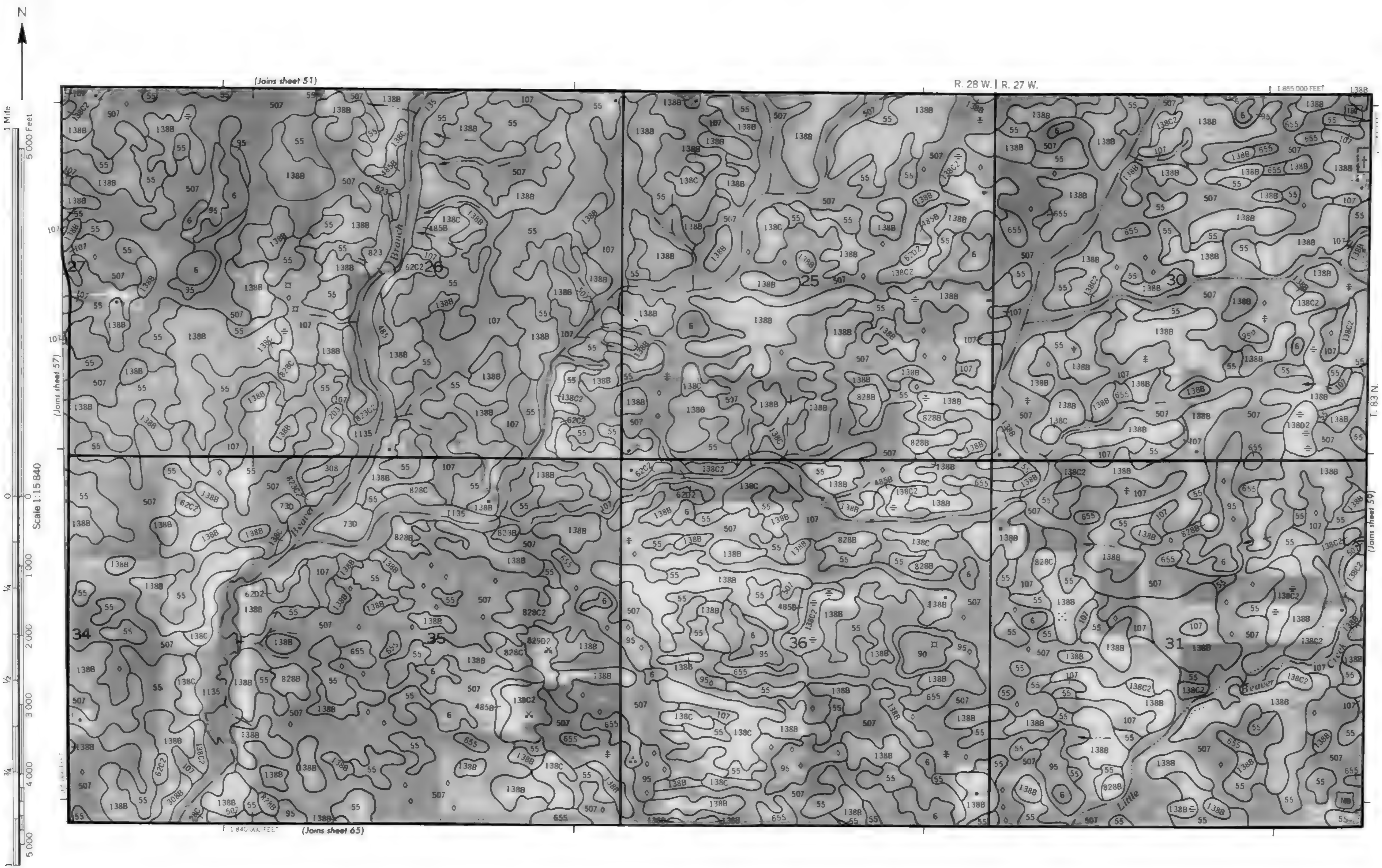

N
(Joins sheet 46)
R 27 W | R 26 W
T 83 N
(Joins sheet 52)
(Joins sheet 54)
(Joins sheet 60)
SAYLORVILLE DES MOINES RESERVOIR
DES MOINES RIVER
SAYLORVILLE DES MOINES RESERVOIR RIVER
LEDGES STATE PARK
Bear Creek
APPROXIMATE FLOOD POOL LINE
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000
¼
½
¾

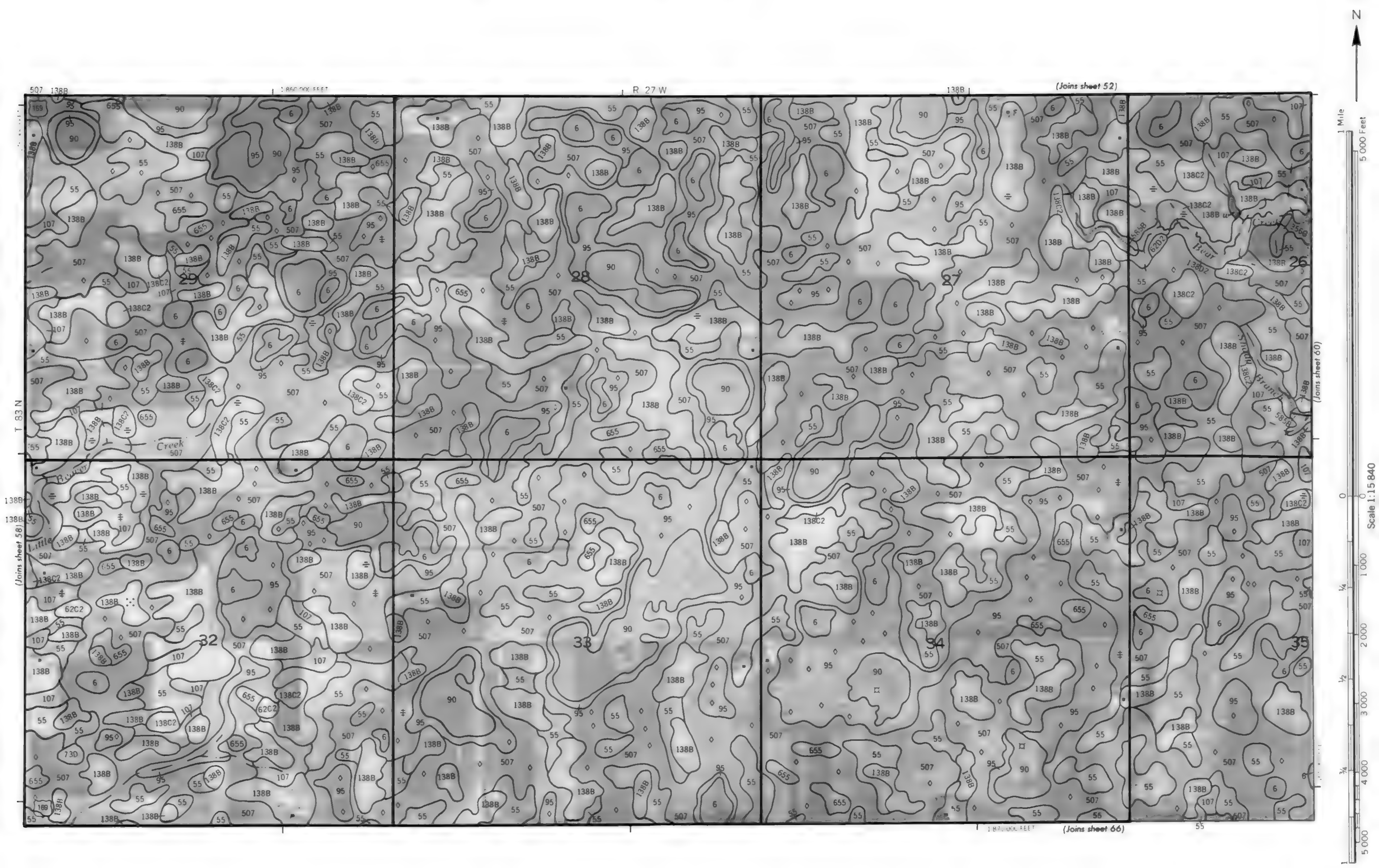

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 47)
(Joins sheet 53)
(Joins sheet 55)
(Joins sheet 61)
R. 26 W.
T. 83 N.
LEDGES
STATE
PARK
Peas Creek
water
Buttrick Branch
13
14
15
16
21
22
23
24


N
R. 26 W. | R. 25 W.
(Joins sheet 48)
(Joins sheet 56)
(Joins sheet 62)
(Joins sheet 54)
T. 83 N.
13
18
17
16
24
19
20
21
Big Creek
Worle Creek
Scale 1:15 840
1 Mile
5 000 Feet
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 49)
R 25 W
(Joins sheet 55)
(Joins sheet 63)
T 83 N
STORY COUNTY
1 935 000 FEET
185 000 FEET
175 000 FEET
Worle Creek
CHICAGO AND NORTH WESTERN
Napier
15
14
13
22
23
24


57
N
(Joins sheet 50)
(Joins sheet 58)
(Joins sheet 64)
R. 28 W.
T. 83 N.
GREENE COUNTY
1 820 000 FEET
1 835 000 FEET
175 000 FEET
BEAVER CREEK
Jim Creek
1 Mile
5 000 Feet
Scale 1:15 840

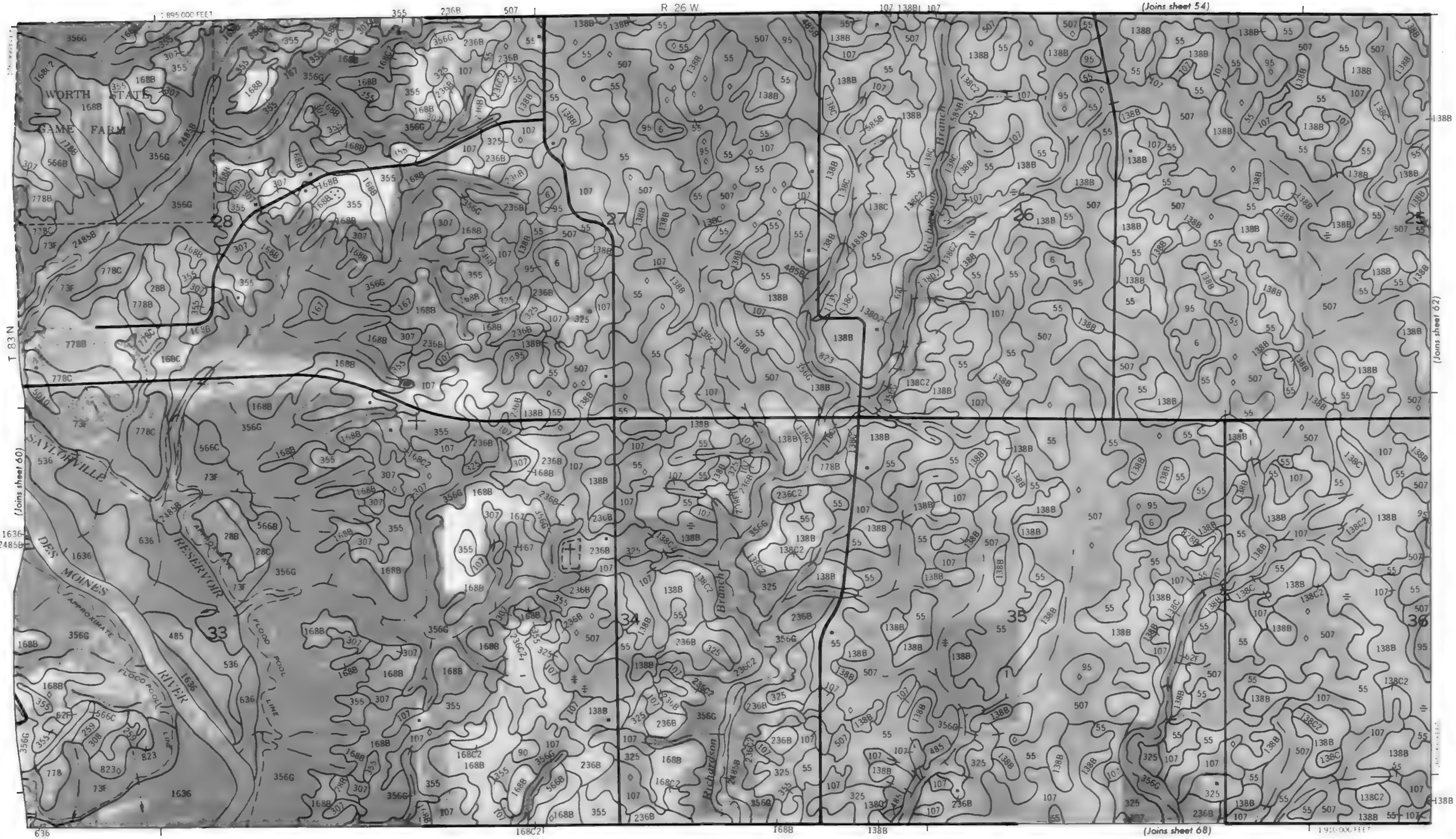

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 51)
(Joins sheet 57)
(Joins sheet 59)
(Joins sheet 65)
R. 28 W. | R. 27 W.
T. 83 N.
1 855 000 FEET
1 840 000 FEET
27
26
25
30
34
35
36
31
Branch
Beaver
Little
Beaver Creek


N
R 27 W
T 83 N
(Joins sheet 52)
(Joins sheet 60)
(Joins sheet 66)
(Joins sheet 58)
29
28
27
26
32
33
34
35
Creek
Little
Bear
Shady Branch
1 Mile
5 000 Feet
Scale 1:15 840

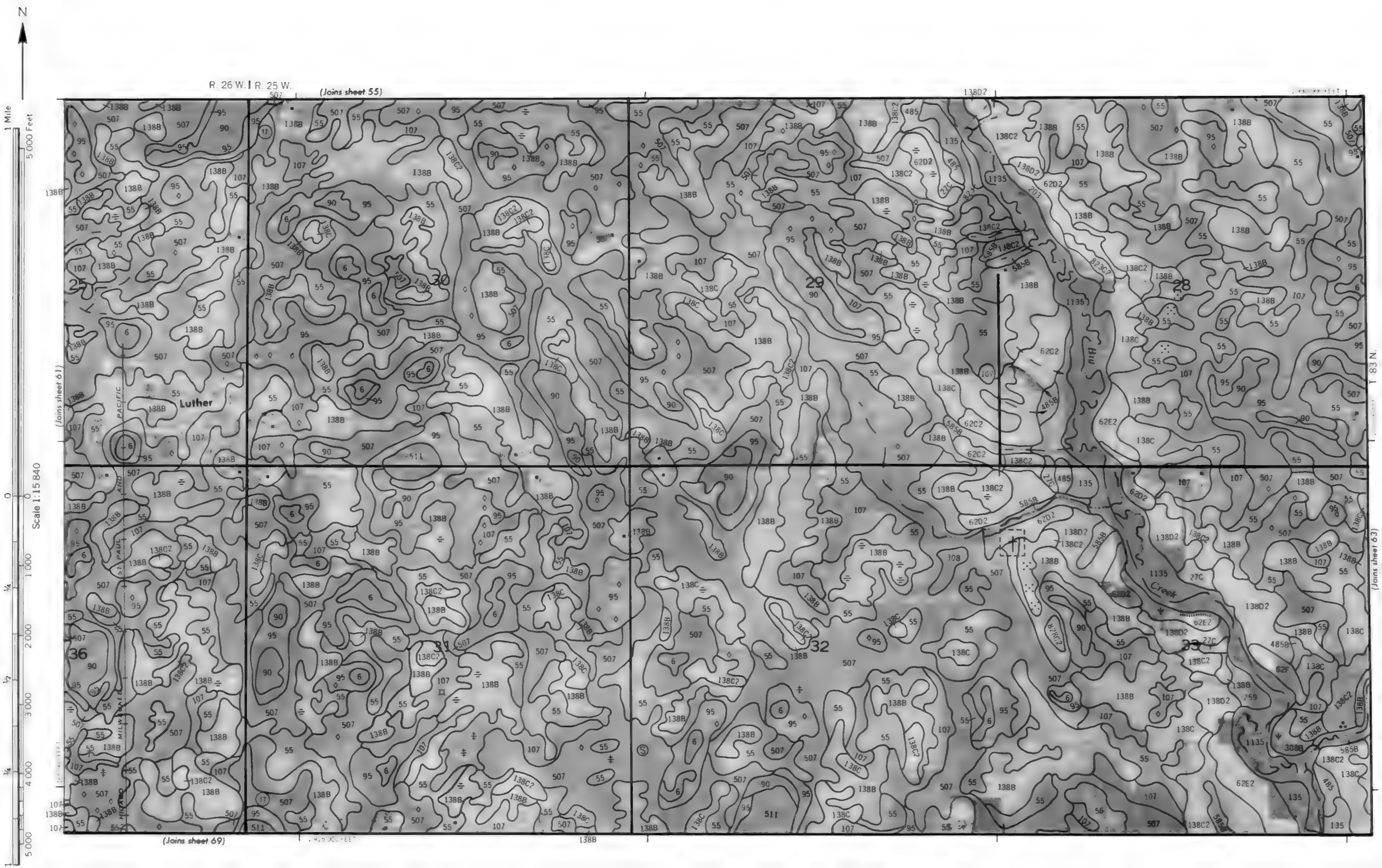

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 53)
R. 27 W. | R. 26 W.
(Joins sheet 59)
(Joins sheet 61)
(Joins sheet 67)
T. 83 N.
Bear Creek
Shady Branch
Bear Creek
DES MOINES RIVER
SAYLORVILLE RESERVOIR
WORTH STATE GAME FARM
APPROXIMATE FLOOD POOL LINE
FLOOD POOL LINE
25
26
29
30
31
32
35
36

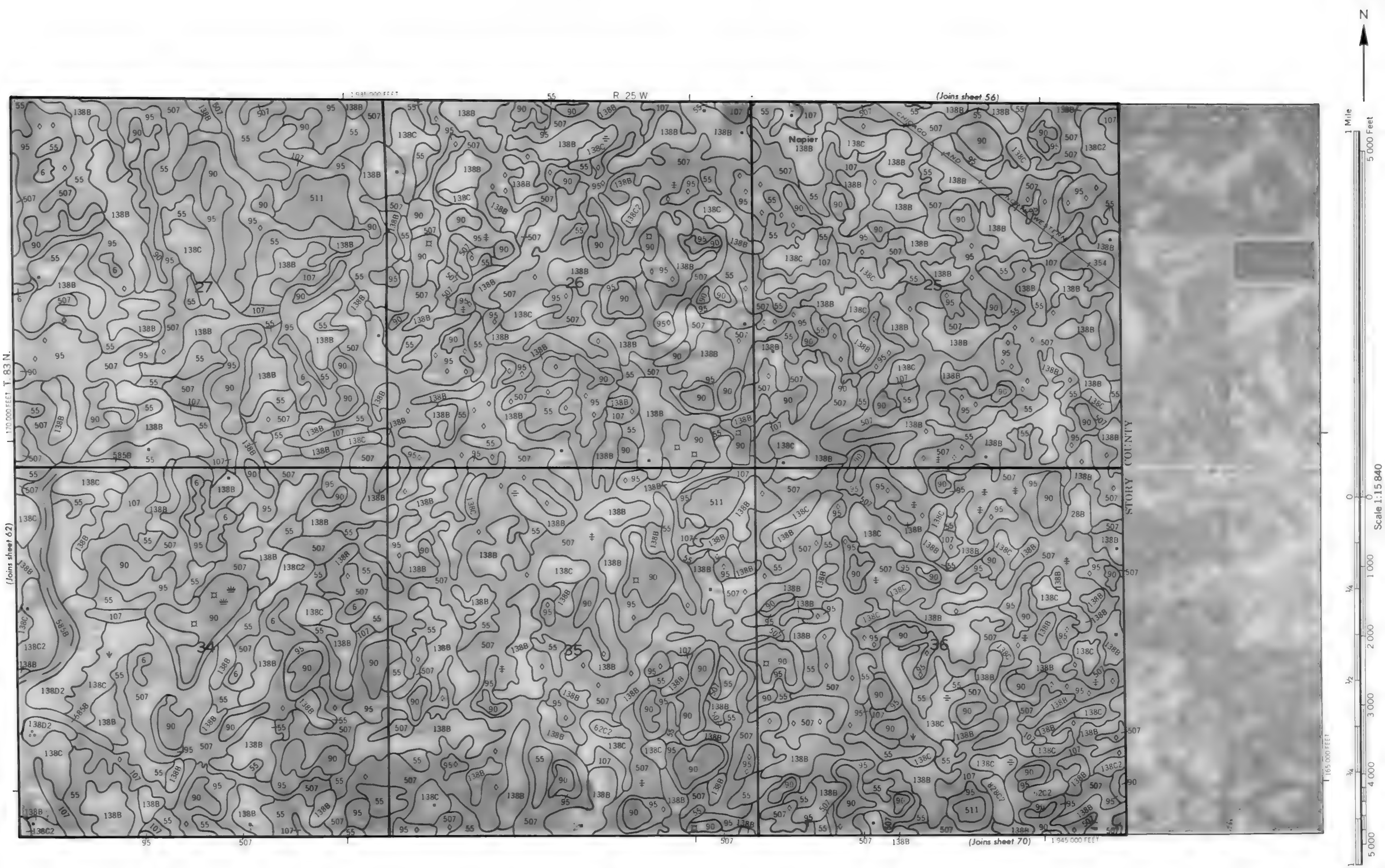
61

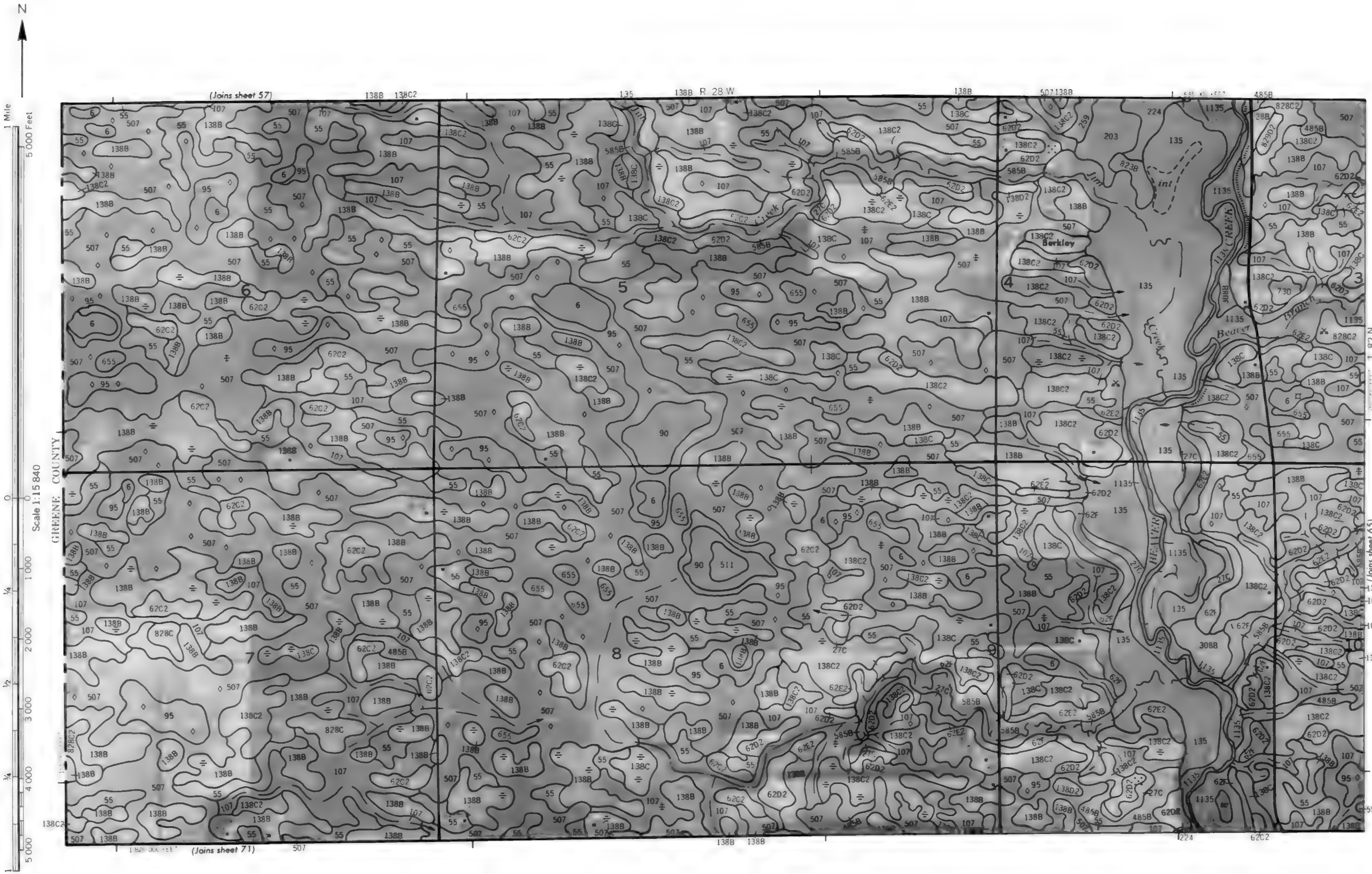
N



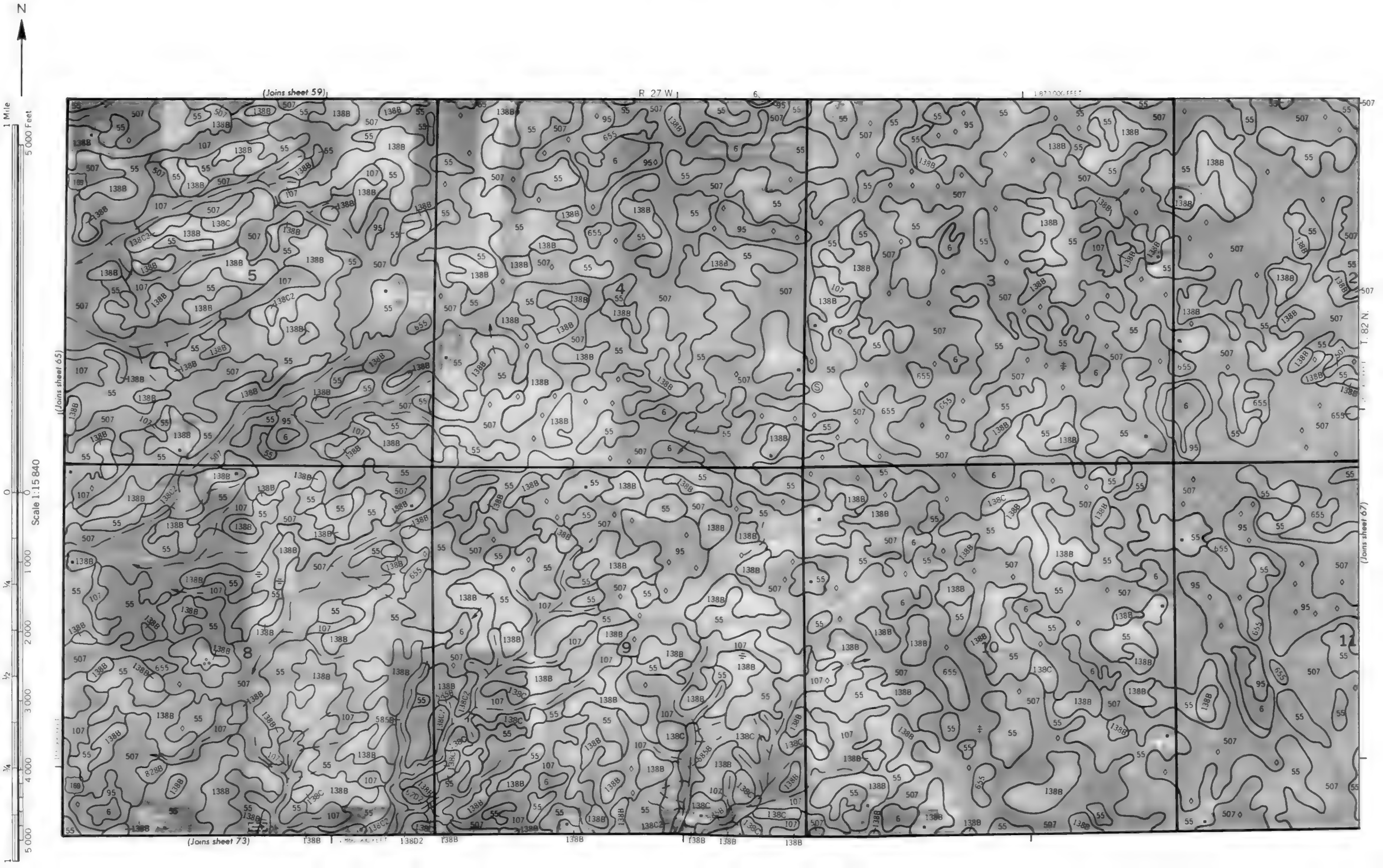
1 895 000 FEET
R. 26 W.
(Joins sheet 54)
(Joins sheet 62)
(Joins sheet 68)
(Joins sheet 60)
T. 83 N.
1 910 000 FEET
WORTH STATE GAME FARM
SAYLORVILLE RESERVOIR
DES MOINES RIVER
Richardson Branch
FLOOD POOL LINE
APPROXIMATE FLOOD POOL LINE
28
27
26
25
33
34
35
36
1 Mile
5 000 Feet
Scale 1:15 840


N
R. 26 W. | R. 25 W.
(Joins sheet 55)
(Joins sheet 61)
(Joins sheet 63)
(Joins sheet 69)
T. 83 N.
Luther
Creek
25
30
29
28
36
31
32
33
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

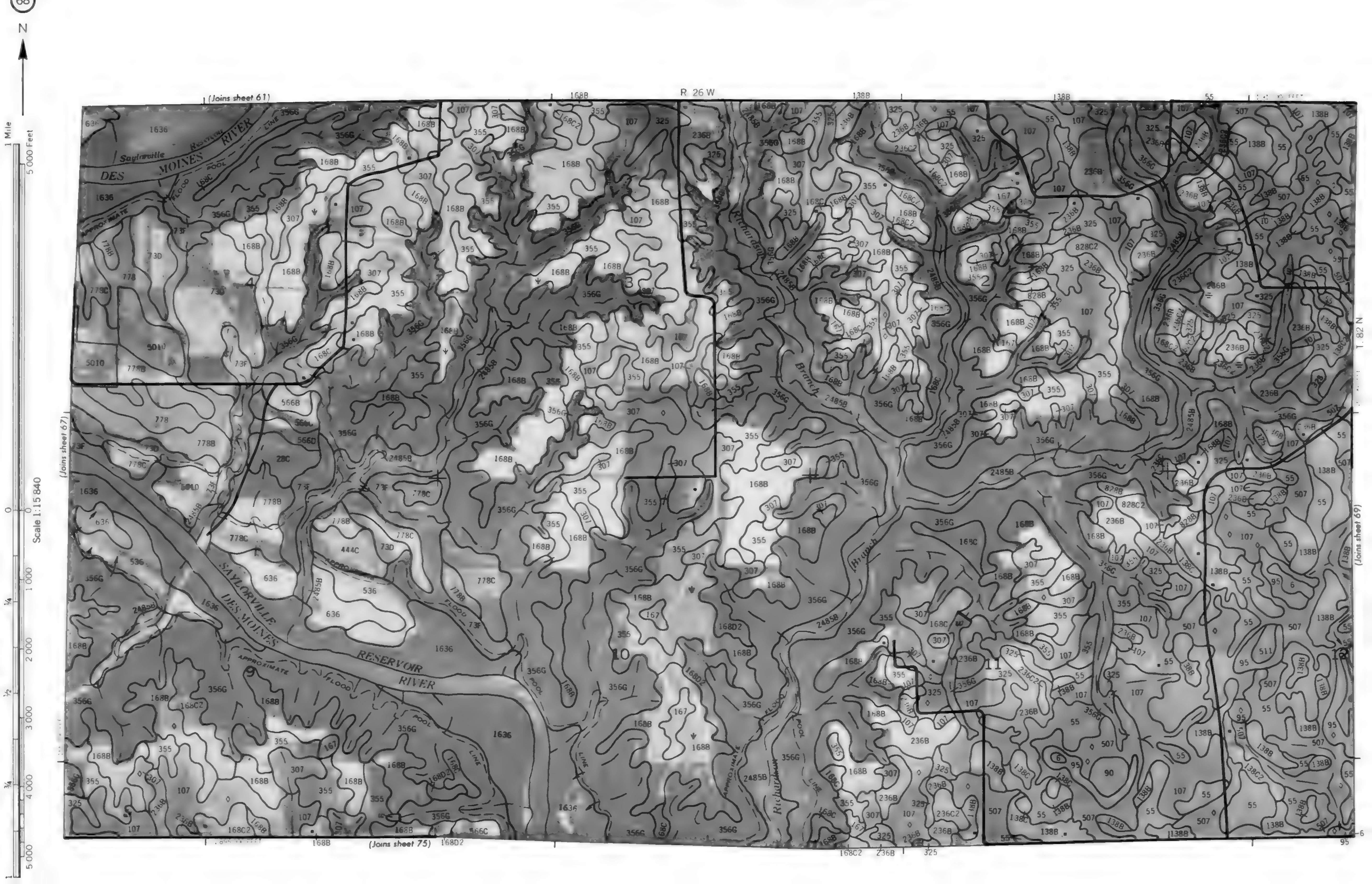

N
R. 25 W
T. 83 N.
(Joins sheet 56)
(Joins sheet 62)
(Joins sheet 70)
1 945 000 FEET
170 000 FEET
165 000 FEET
Napier
CHICAGO AND NORTH WESTERN
STORY COUNTY
27
26
25
34
35
36
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000
¼
½
¾

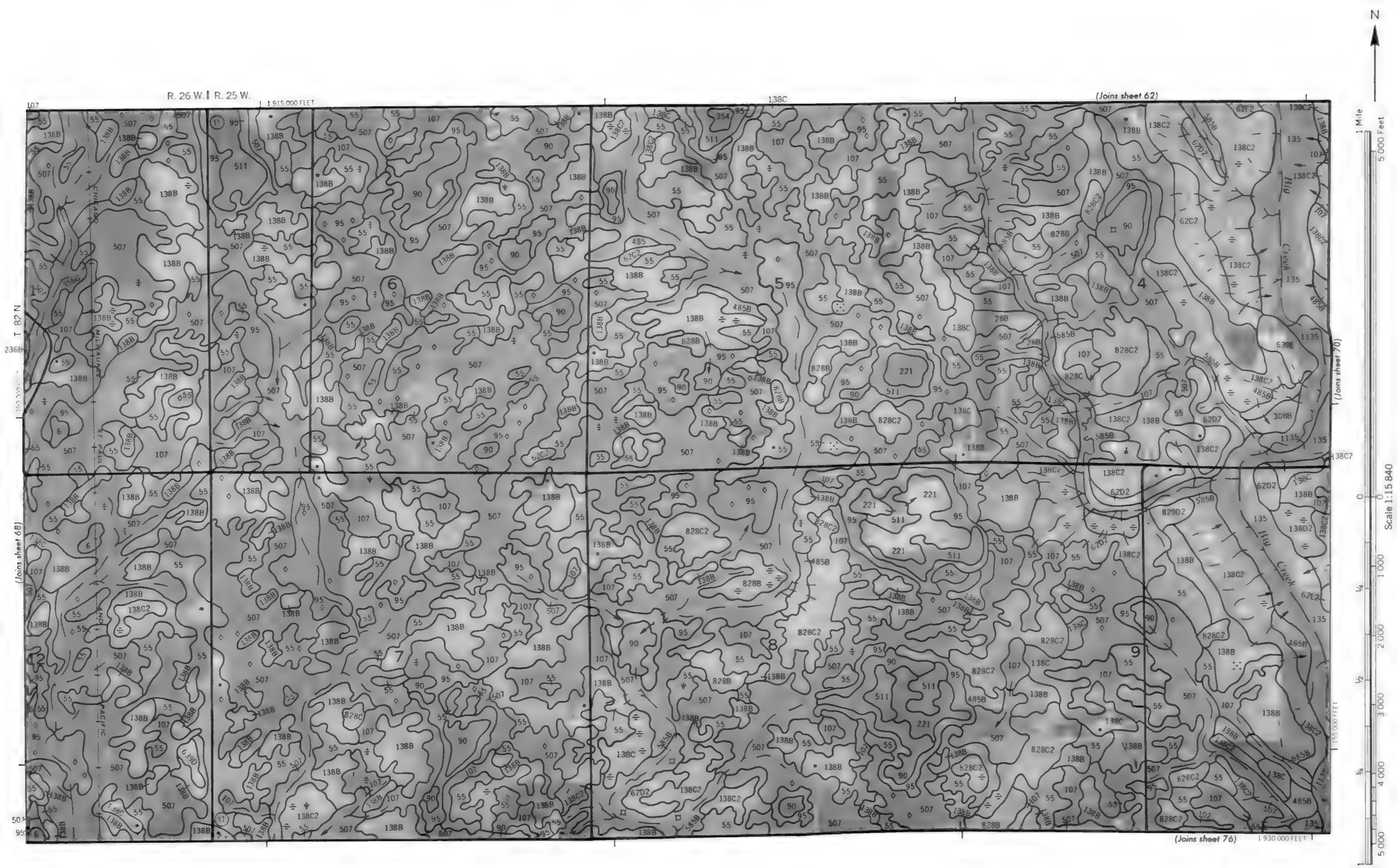

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 57)
R. 28 W.
T. 82 N.
(Joins sheet 65)
(Joins sheet 71)
GREENE COUNTY
Berkley
Beaver Creek
Beaver Branch


65
N
R. 28 W. R. 27 W.
(Joins sheet 58)
(Joins sheet 66)
(Joins sheet 72)
(Joins sheet 64)
T. 82 N.
Little Beaver Creek
Branch
1 Mile
5 000 Feet
Scale 1:15 840

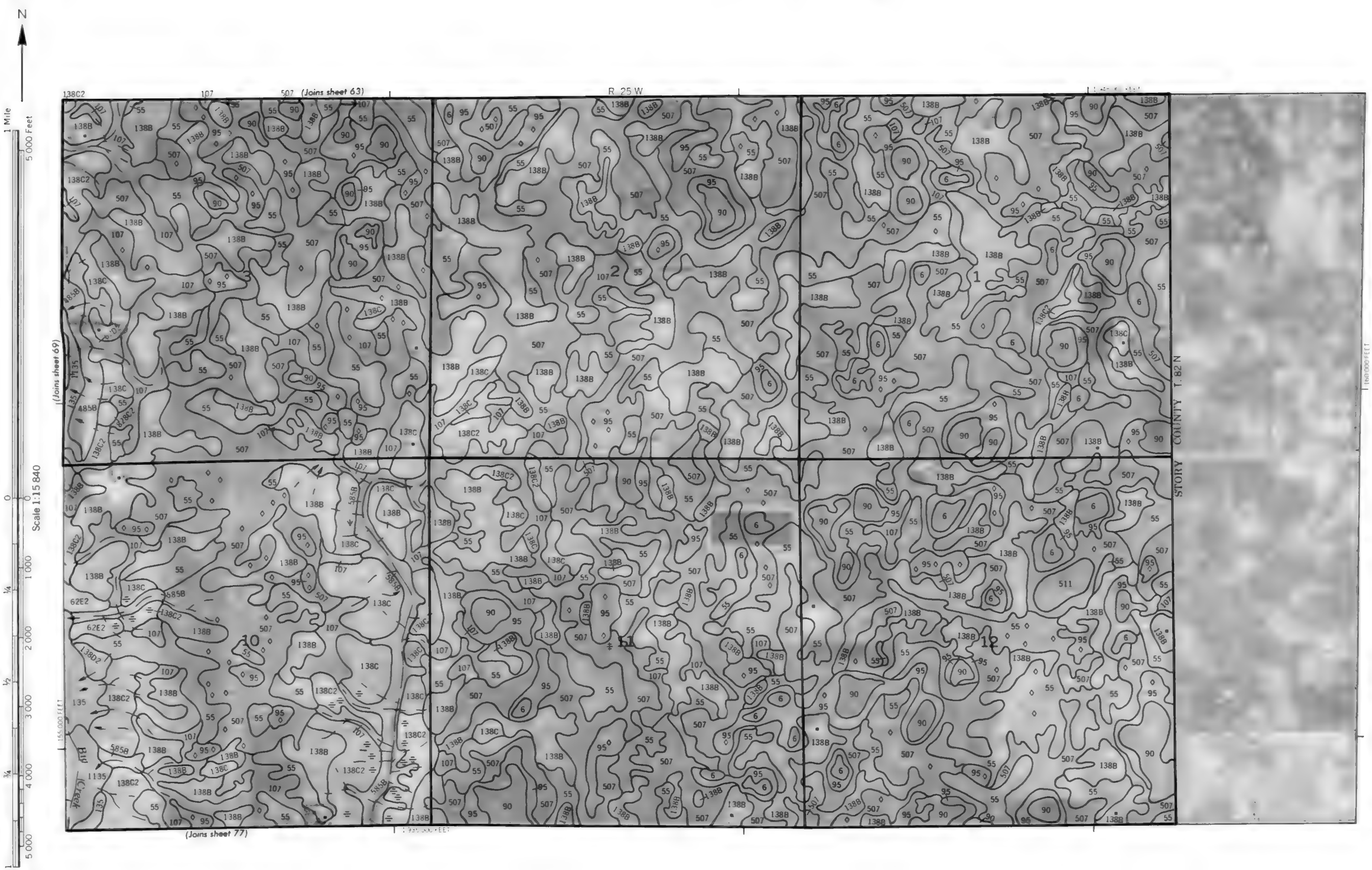

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 59)
R. 27 W.
T. 82 N.
(Joins sheet 65)
(Joins sheet 67)
(Joins sheet 73)
5
4
3
2
8
9
10
11

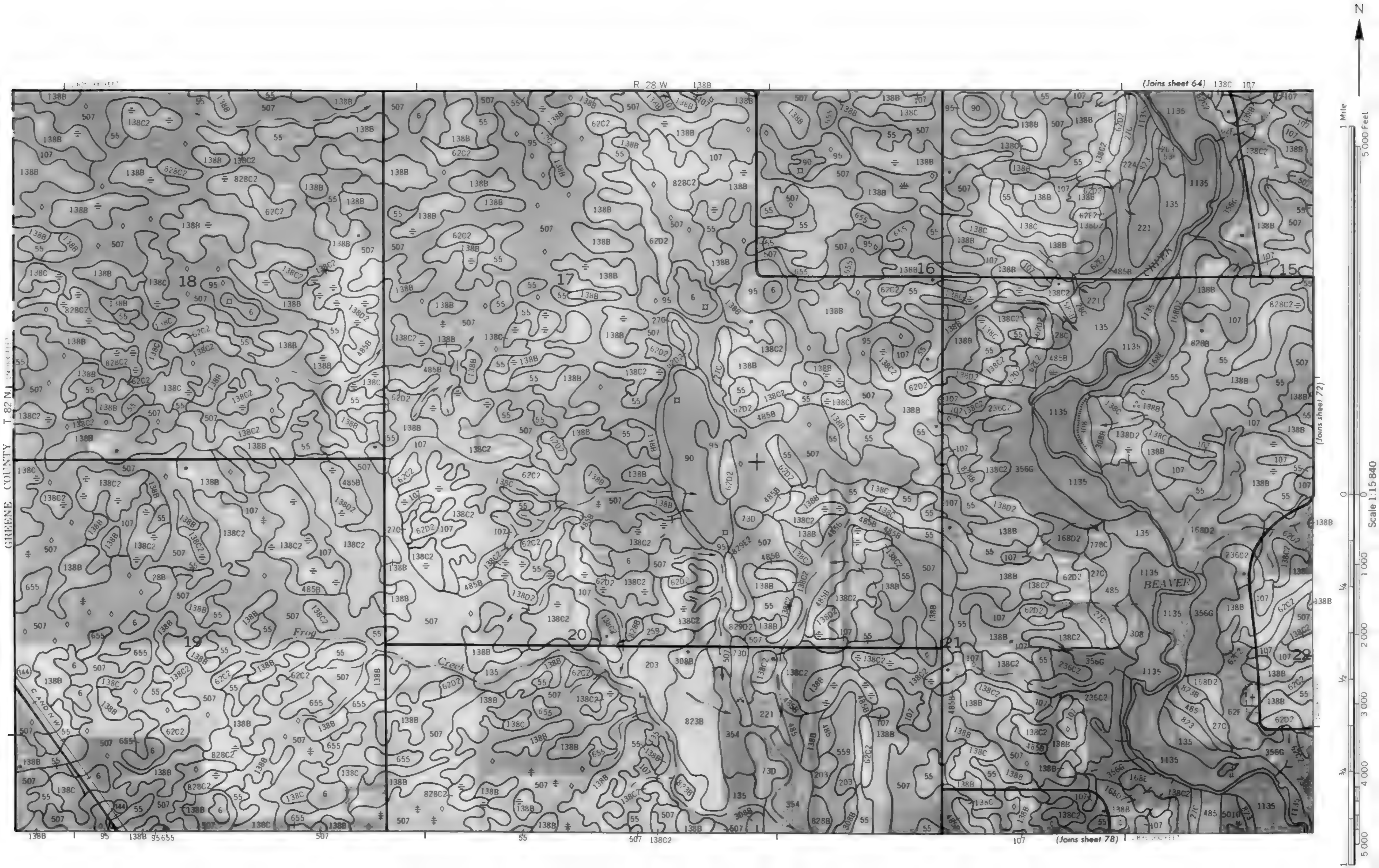

N
R. 27 W. | R. 26 W.
(Joins sheet 60)
(Joins sheet 68)
(Joins sheet 74)
(Joins sheet 66)
T. 82 N.
DES MOINES RIVER
Saylorville Reservoir
APPROXIMATE FLOOD POOL LINE
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 61)
R 26 W
T. 82 N
(Joins sheet 67)
(Joins sheet 69)
(Joins sheet 75)
DES MOINES RIVER
SAYLORVILLE FLOOD POOL LINE
APPROXIMATE
SAYLORVILLE DES MOINES RESERVOIR RIVER
APPROXIMATE FLOOD POOL LINE
Richardson Branch
Richardson
4
3
2
9
10
11
12

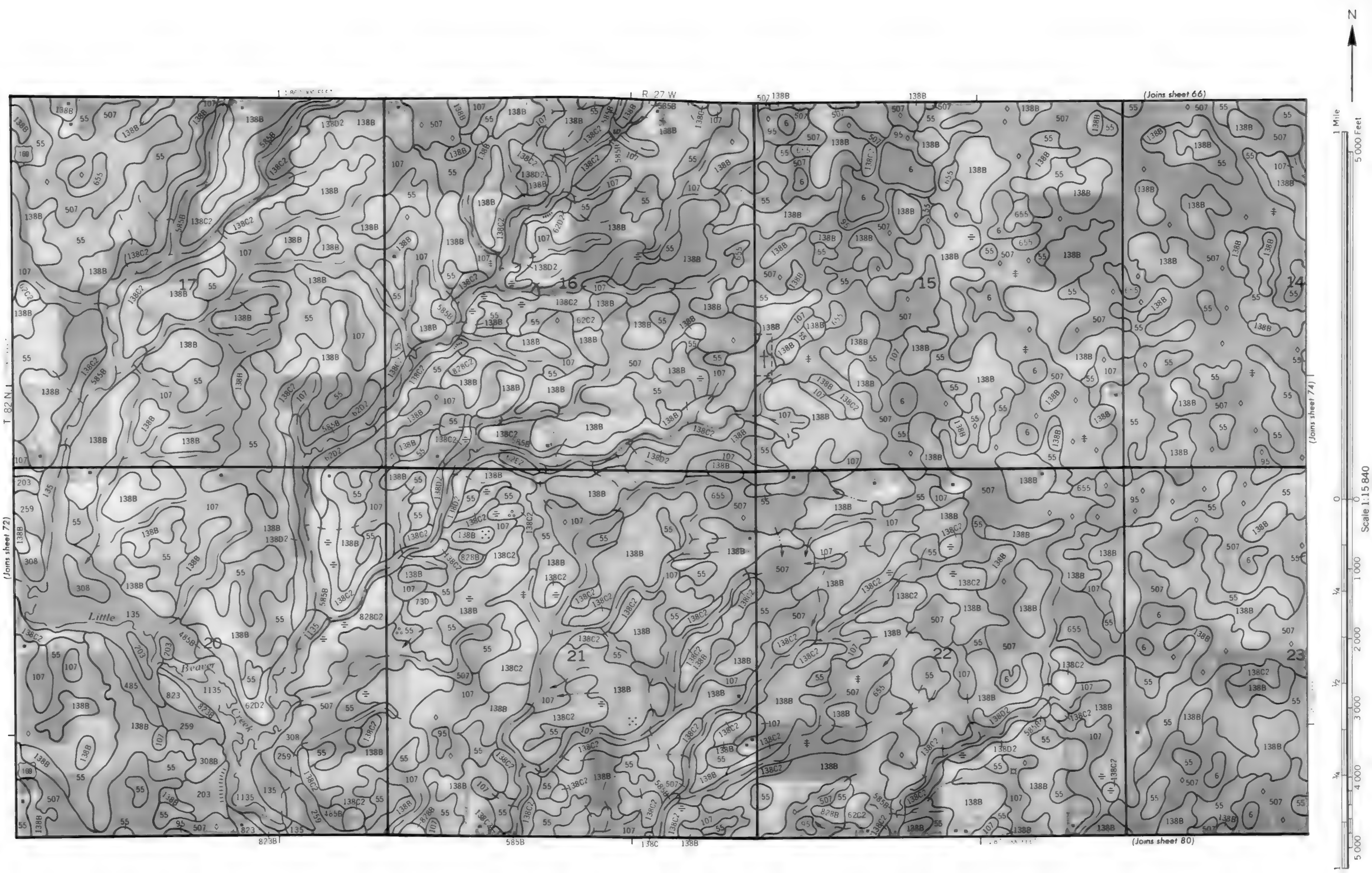

N
R. 26 W.
R. 25 W.
1 915 000 FEET
(Joins sheet 62)
(Joins sheet 70)
(Joins sheet 76)
(Joins sheet 68)
T. 82 N.
1 930 000 FEET
155 000 FEET
Big Creek
Chicago Milwaukee St Paul and Pacific
1 Mile
5 000 Feet
Scale 1:15 840
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000

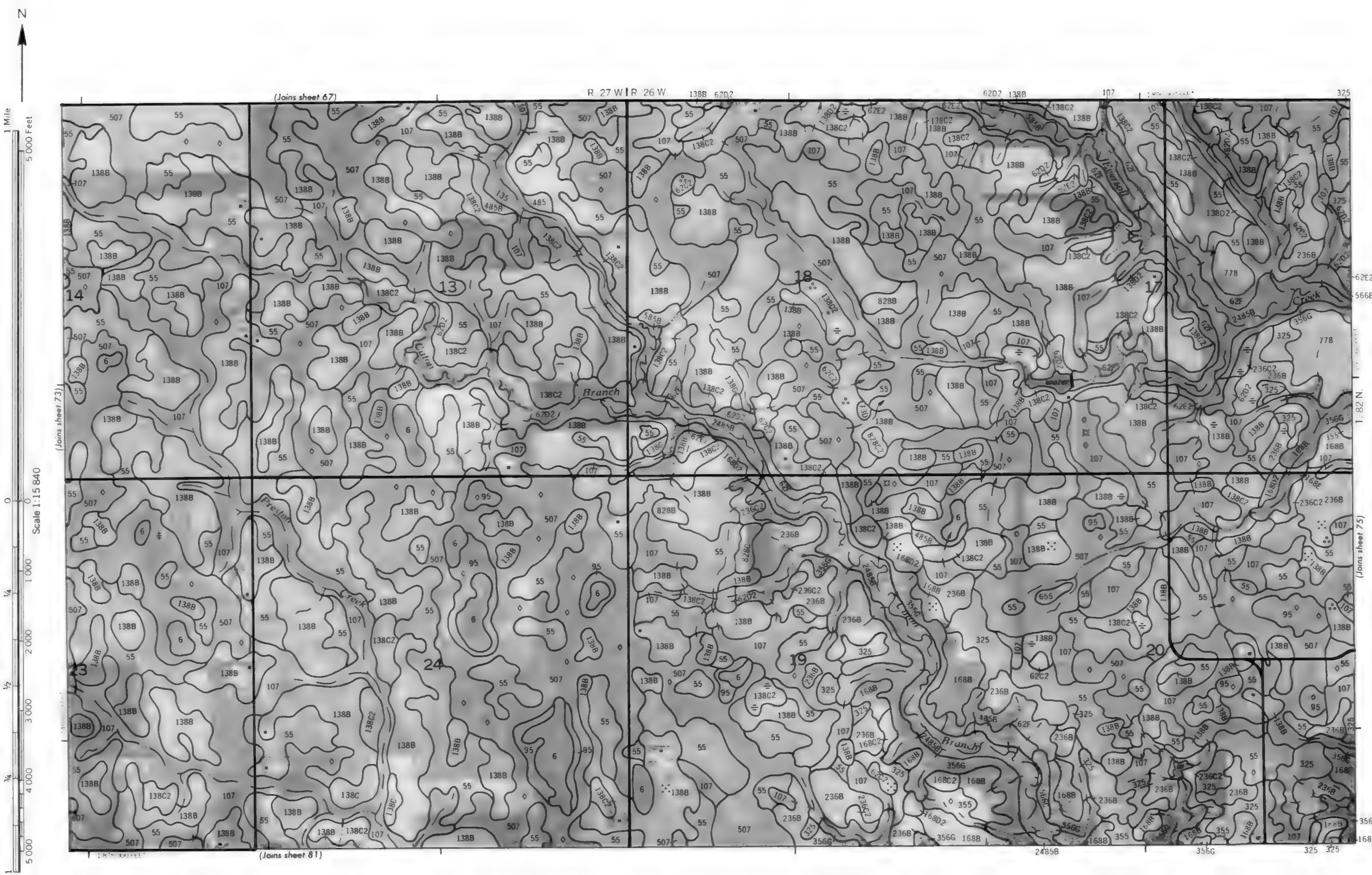
BOONE COUNTY, IOWA — SHEET NUMBER 70



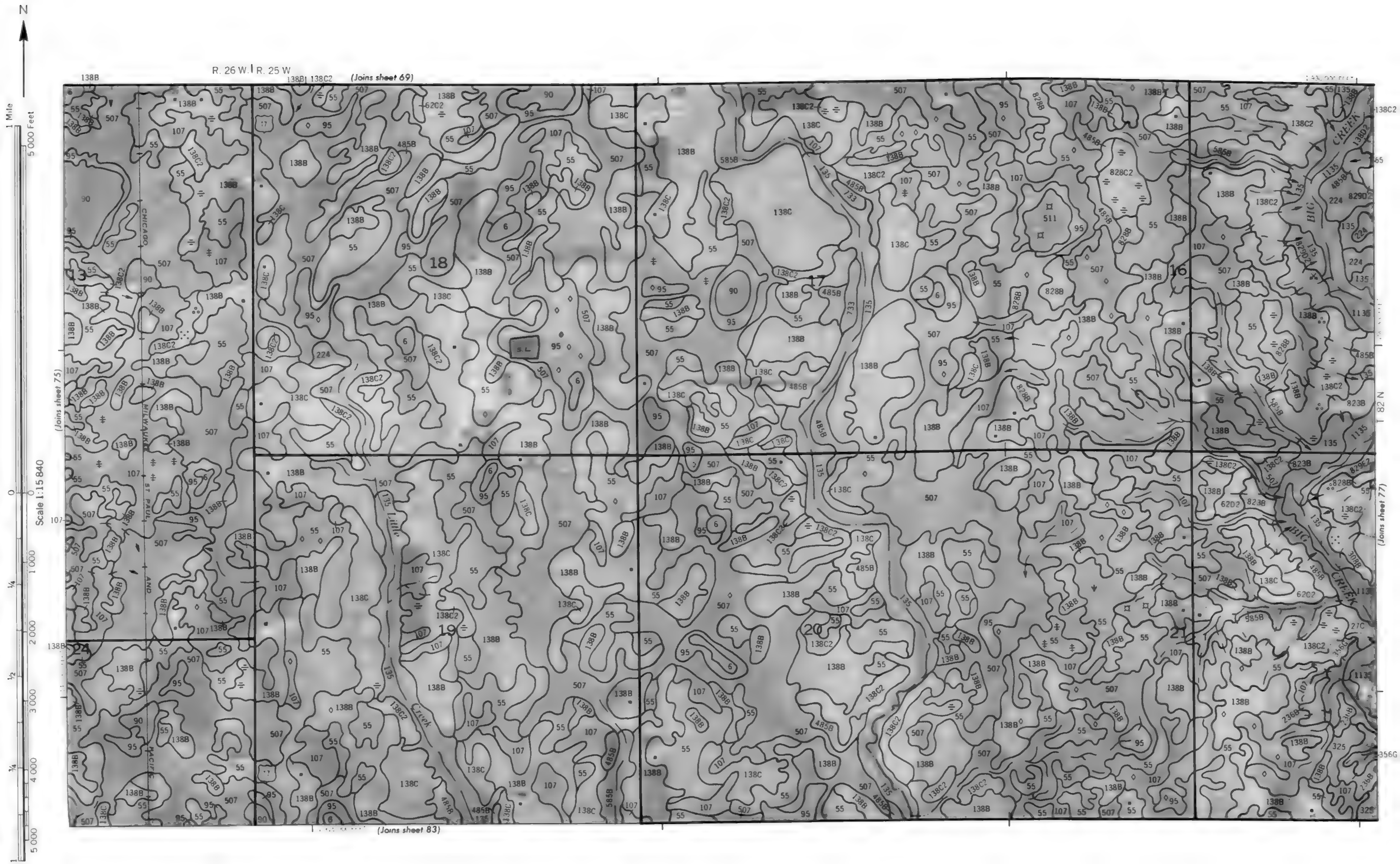

N
R. 28 W.
(Joins sheet 64)
(Joins sheet 72)
(Joins sheet 78)
GREENE COUNTY
T. 82 N.
15
16
17
18
19
20
21
22
Frog
Creek
BEAVER
CREEK
C AND N W
144
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000
¼
½
¾

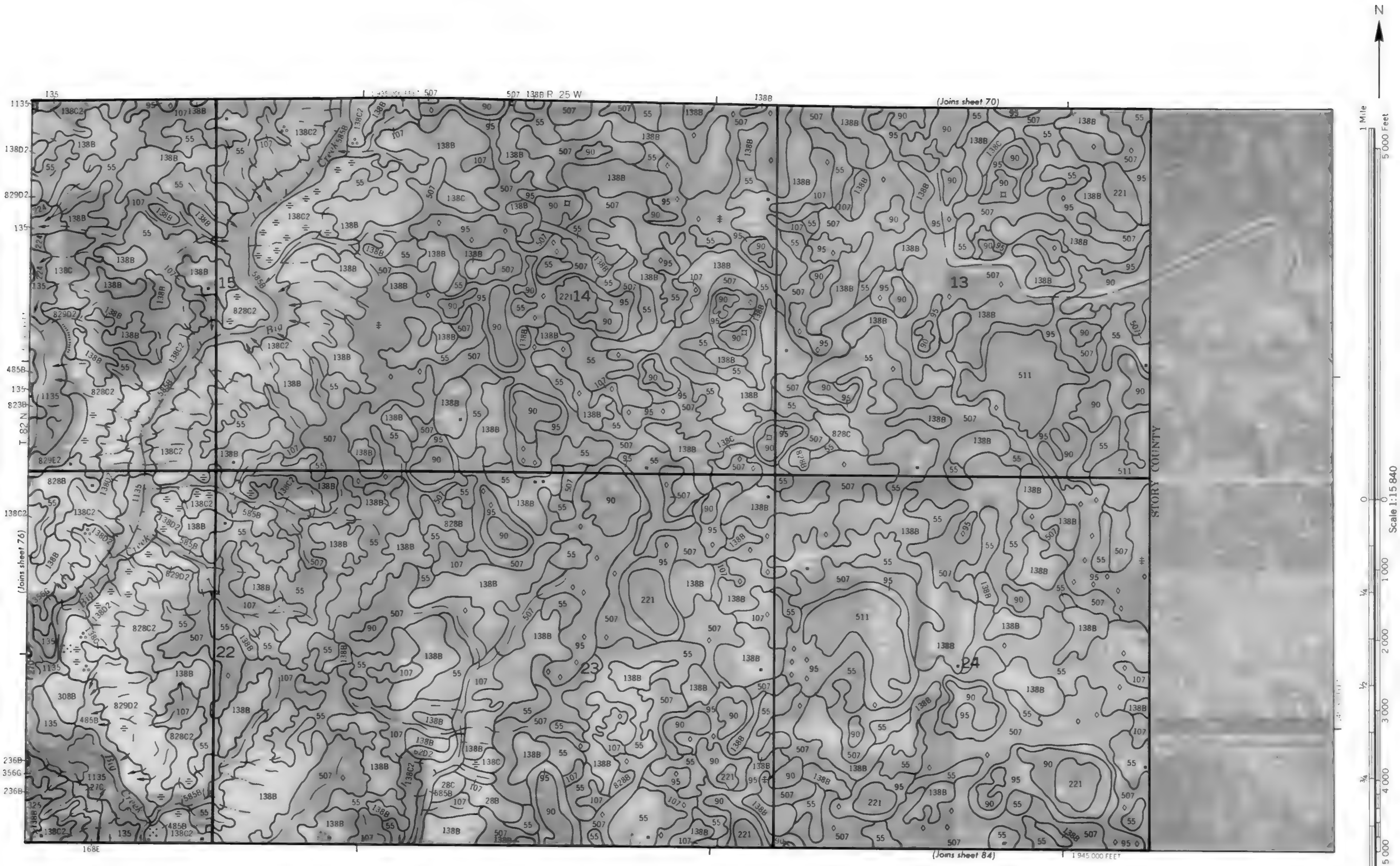
BOONE COUNTY, IOWA — SHEET NUMBER 72

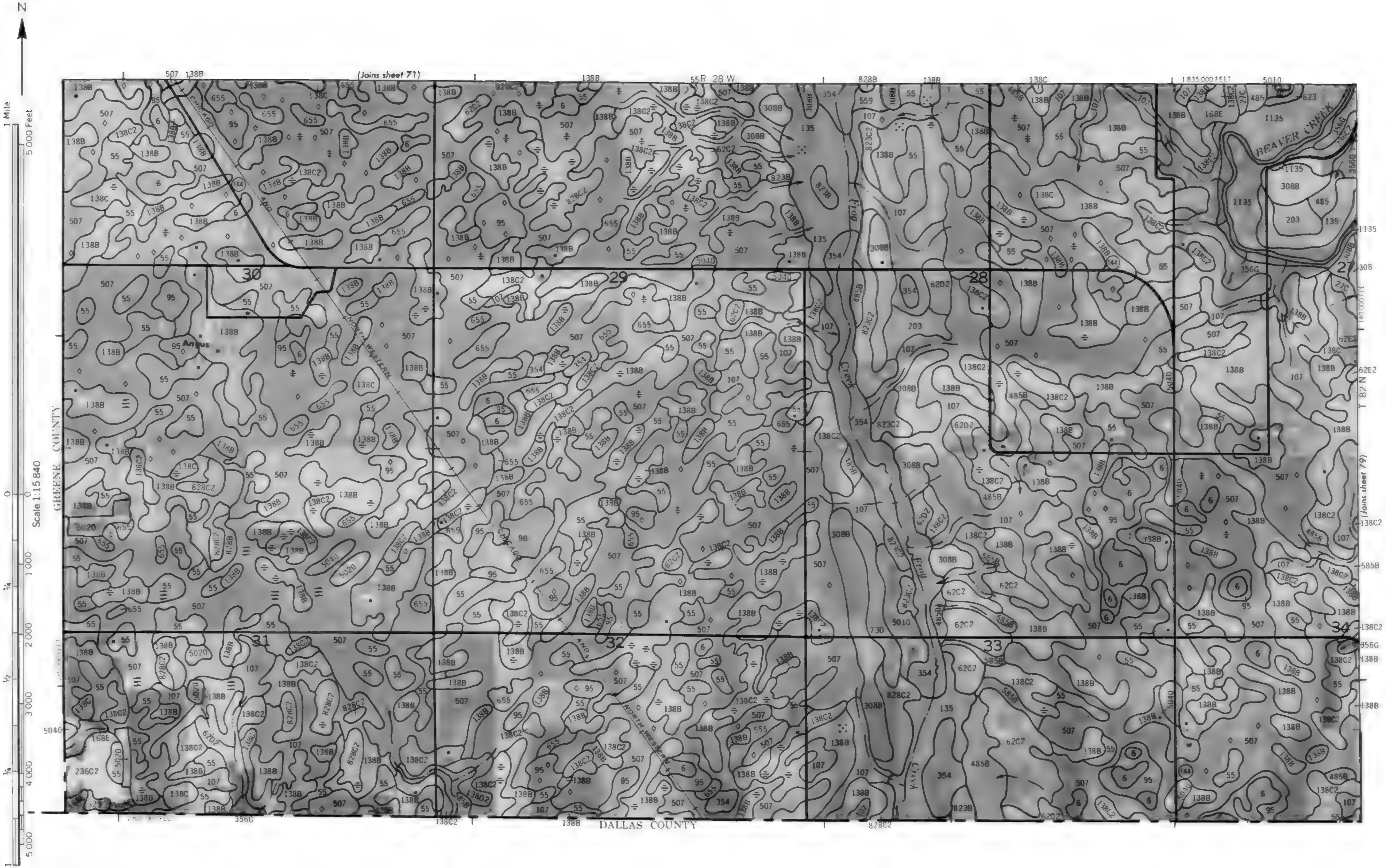

N
R 27 W
T 82 N
(Joins sheet 66)
(Joins sheet 72)
(Joins sheet 74)
(Joins sheet 80)
17
16
15
14
20
21
22
23
Little
Beaver
Creek
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000

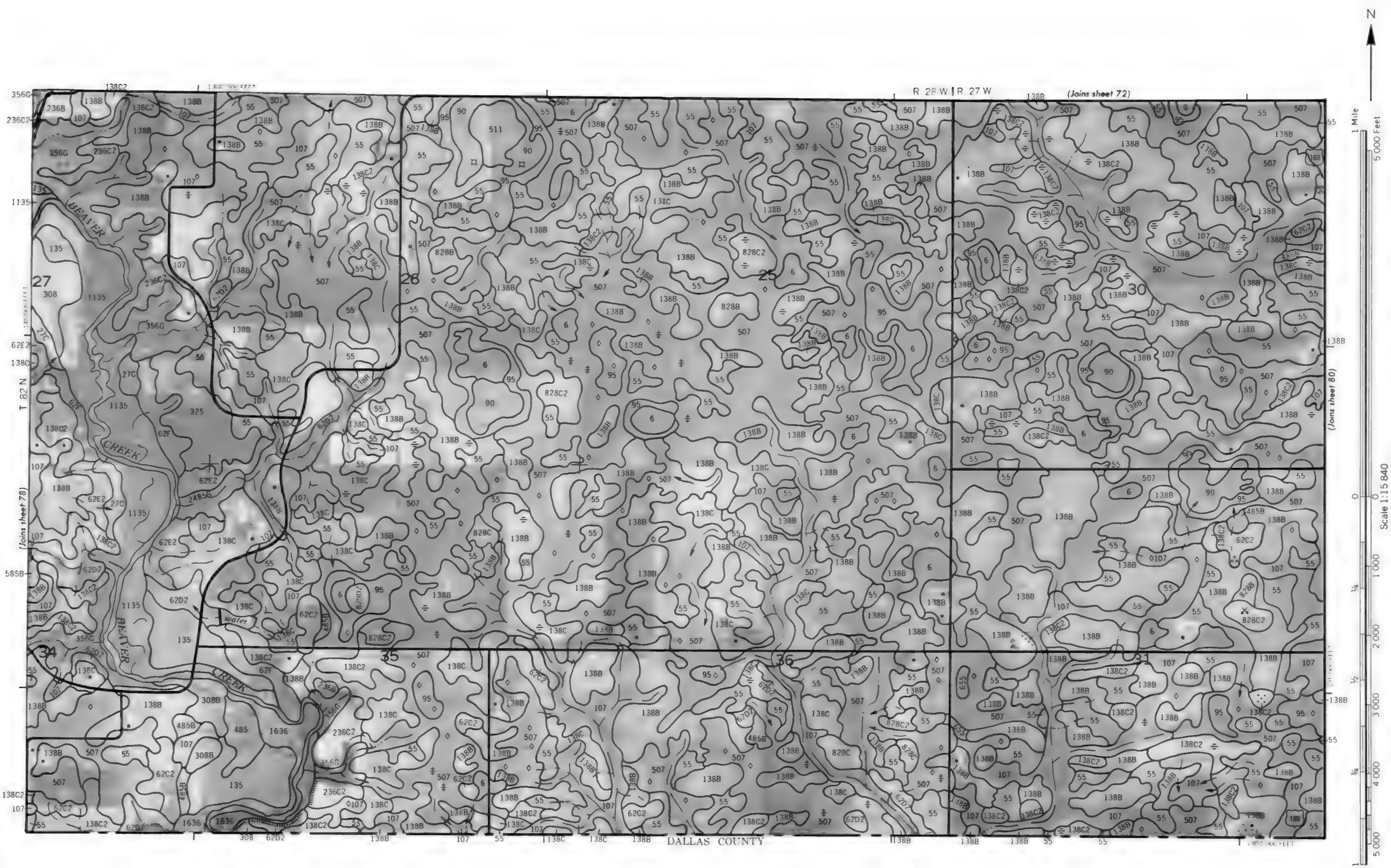

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 67)
R. 27 W. | R. 26 W.
T. 82 N.
(Joins sheet 73)
(Joins sheet 75)
(Joins sheet 81)
13
14
17
18
19
20
23
24
Branch
Preston Creek
Creek
Branch
water


75
N
(Joins sheet 68)
(Joins sheet 76)
(Joins sheet 74)
(Joins sheet 82)
R. 26 W.
T. 82 N.
SAYLORVILLE
DES MOINES RIVER
RESERVOIR
Richardson Branch
Eversoll Creek
APPROXIMATE FLOOD POOL LINE
Scale 1:15 840
1 Mile
5 000 Feet

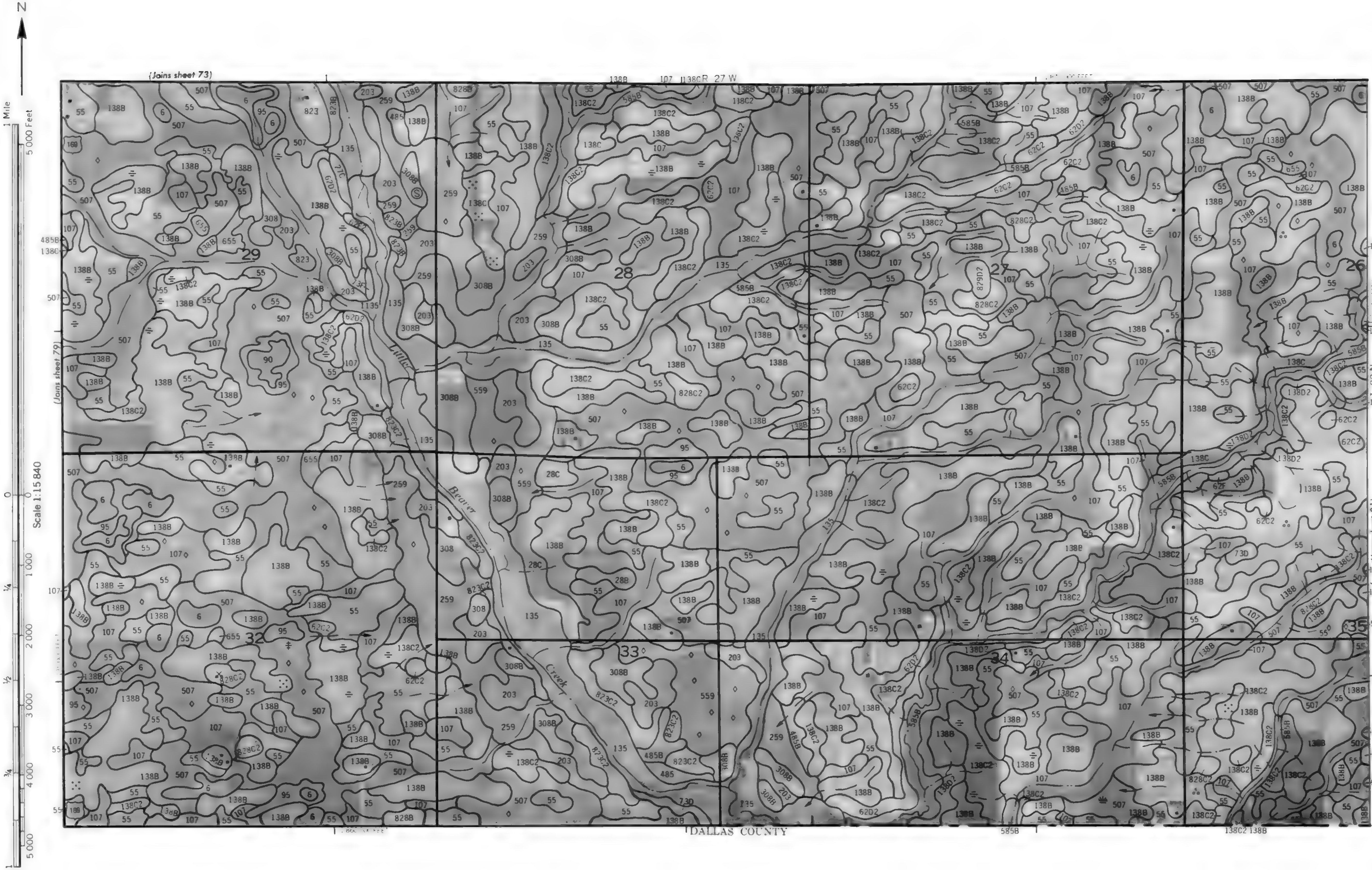

N
1 Mile
5 000 Feet
Scale 1:15 840
R. 26 W. | R. 25 W.
(Joins sheet 69)
(Joins sheet 75)
(Joins sheet 77)
(Joins sheet 83)
T. 82 N.
13
16
17
18
19
20
21
24
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
Little Creek
BIG CREEK


N
(Joins sheet 70)
(Joins sheet 84)
(Joins sheet 76)
R 25 W
T. 82 N.
STORY COUNTY
15
14
13
22
23
24
1 945 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840


N
(Joins sheet 71)
R 28 W
1 835 000 FEET
BEAVER CREEK
Angus
GREENE COUNTY
DALLAS COUNTY
(Joins sheet 79)
T 82 N
CHICAGO AND NORTH WESTERN
Frog Creek
27
28
29
30
31
32
33
34
1 Mile
5 000 Feet
Scale 1:15 840

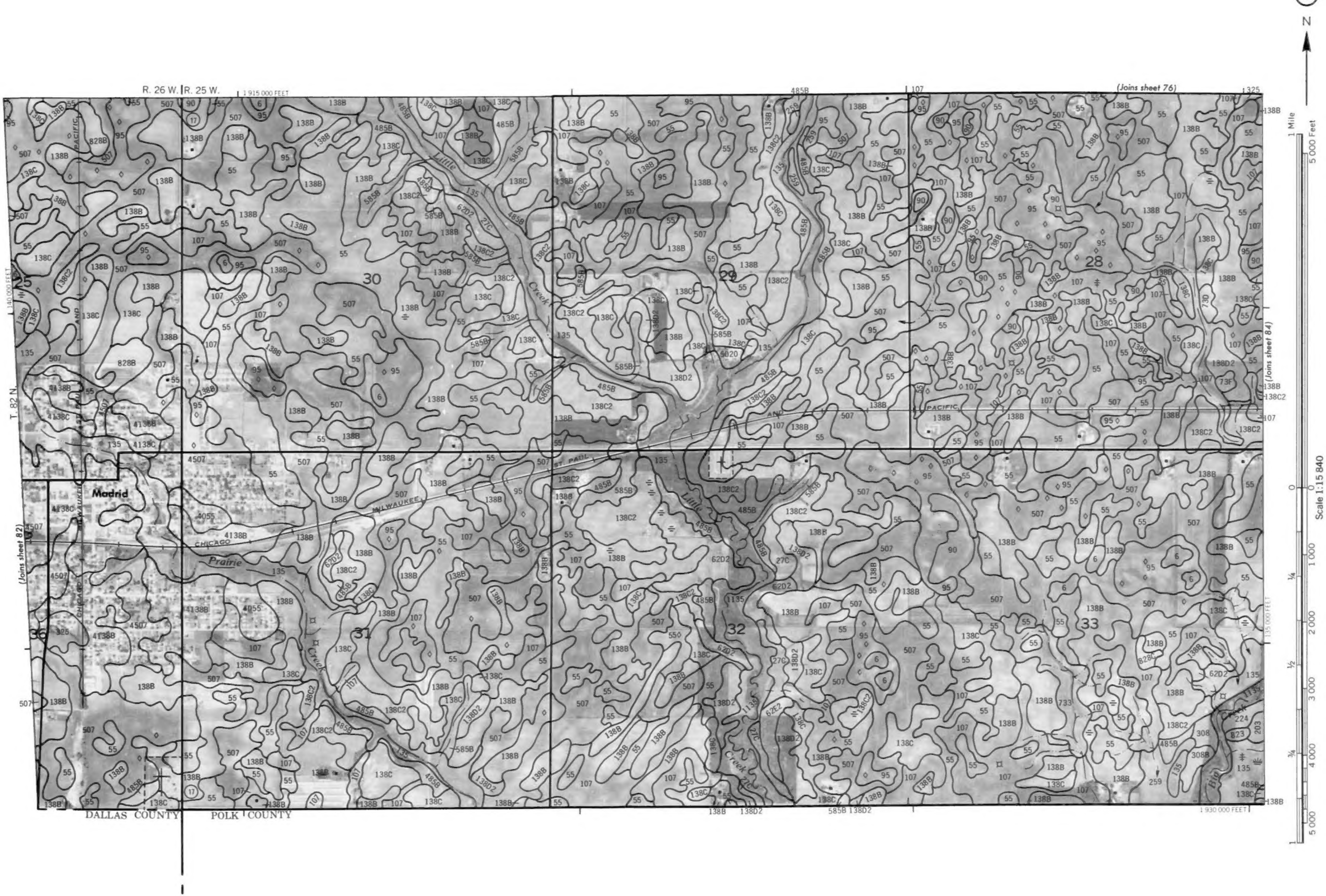

N
R. 28 W. | R. 27 W.
(Joins sheet 72)
(Joins sheet 80)
(Joins sheet 78)
T 82 N
BEAVER CREEK
DALLAS COUNTY
27
26
25
30
34
35
36
31
1 Mile
5 000 Feet
Scale 1:15 840

BOONE COUNTY, IOWA — SHEET NUMBER 80




N
R. 27 W.
R. 26 W.
(Joins sheet 74)
(Joins sheet 80)
(Joins sheet 82)
T. 82 N.
1 875 000 FEET
1 890 000 FEET
140 000 FEET
135 000 FEET
Caton Branch
Preston Creek
WOODWARD STATE HOSPITAL AND SCHOOL
DALLAS COUNTY
25
26
29
30
31
32
35
36
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
¼
2000
½
3000
¾
4000
5000
(Joins sheet 75)
(Joins sheet 81)
(Joins sheet 83)
R. 26 W.
T. 82 N.
1 910 000 FEET
1 895 000 FEET
135 000 FEET
140 000 FEET
DES MOINES RIVER
SAYLORVILLE RESERVOIR
Caton Branch
Eversoll Creek
Preston Creek
APPROXIMATE FLOOD POOL LINE
water
CHICAGO MILWAUKEE ST. PAUL AND PACIFIC
Madrid
DALLAS COUNTY
25
26
27
28
33
34
35
36


83
N
R. 26 W.
R. 25 W.
1 915 000 FEET
(Joins sheet 76)
(Joins sheet 84)
(Joins sheet 82)
T. 82 N.
140 000 FEET
135 000 FEET
1 930 000 FEET
Madrid
Little Creek
Prairie Creek
Big Creek
CHICAGO MILWAUKEE ST. PAUL AND PACIFIC
25
28
29
30
31
32
33
36
DALLAS COUNTY
POLK COUNTY
1 Mile
5 000 Feet
Scale 1:15 840
0
¼
½
¾
1 000
2 000
3 000
4 000
5 000

BOONE COUNTY, IOWA — SHEET NUMBER 84